BECKHOFF New Automation Technology

Integrated Building Automation Solutions

For Investors, Planners and Technicians

IPC

I/O

Automation

ZUKUNFTSMEILE 1

Integrated building automation for investors, planners and technicians

With this catalog we would like to provide investors, planners and technicians with solutions to enable them to make future-proof decisions both for new buildings and for modernisation projects. We give a detailed answer to the question about intelligent building automation concepts that cater to the current global and demographic trends: increasing population figures, increasing urbanisation, increasing environmental pollution and at the same time increasingly scarce energy resources, which necessitate an urgent rethink.

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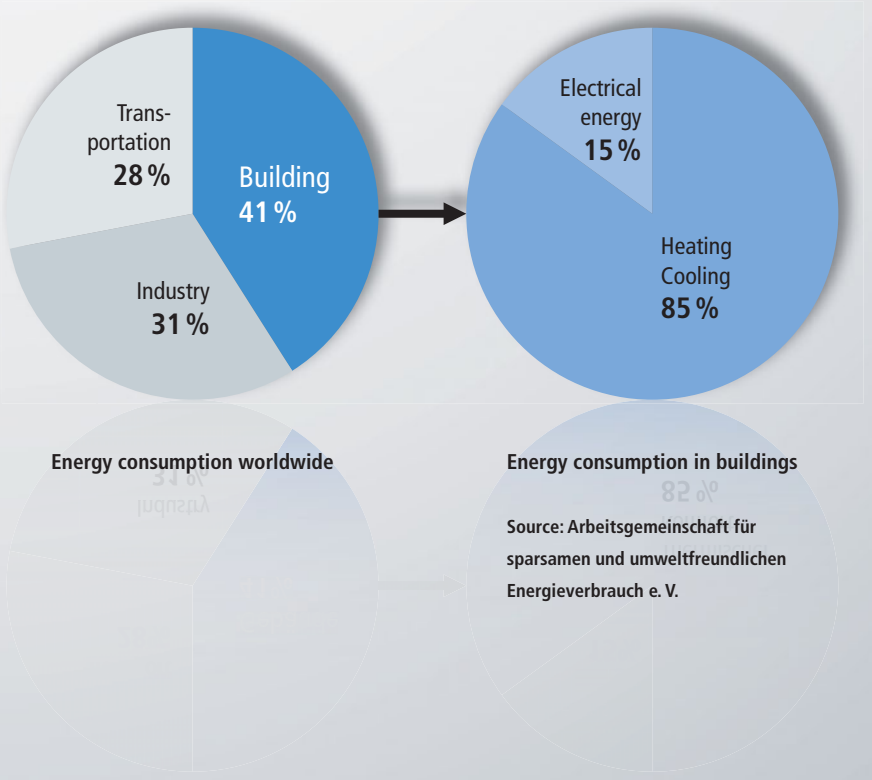

Energy consumption worldwide

Energy consumption in buildings

Source: Arbeitsgemeinschaft für sparsamen und umweltfreundlichen Energieverbrauch e. V.

Consistent investment in the future: Building Automation from Beckhoff.

41 % of the total worldwide primary energy requirement is consumed by buildings. About 85 % of that is used for to the heating or cooling of rooms and 15 % for lighting. This way, it immediately becomes clear that the question of investment in new buildings or modernisation projects is above all a question of optimising energy efficiency. And there are several reasons for that. Firstly, there are ecological reasons: the early assessment of demands during the planning of a building determines whether it already fulfils the desired energy efficiency class today. Secondly, there are economic reasons: with the choice of a highly efficient building automation system from Beckhoff you tap into an energy-saving potential of up to 30 %, which directly affects the rentability of your investment.

How can this be achieved? The answer is: with a system-spanning, holistic automation solution that uses synergies efficiently and drastically reduces the energy consumption of a building. This can be implemented only with the use of an intelligent, software-based control system that has all information from all building systems at its disposal at all times and uses this information

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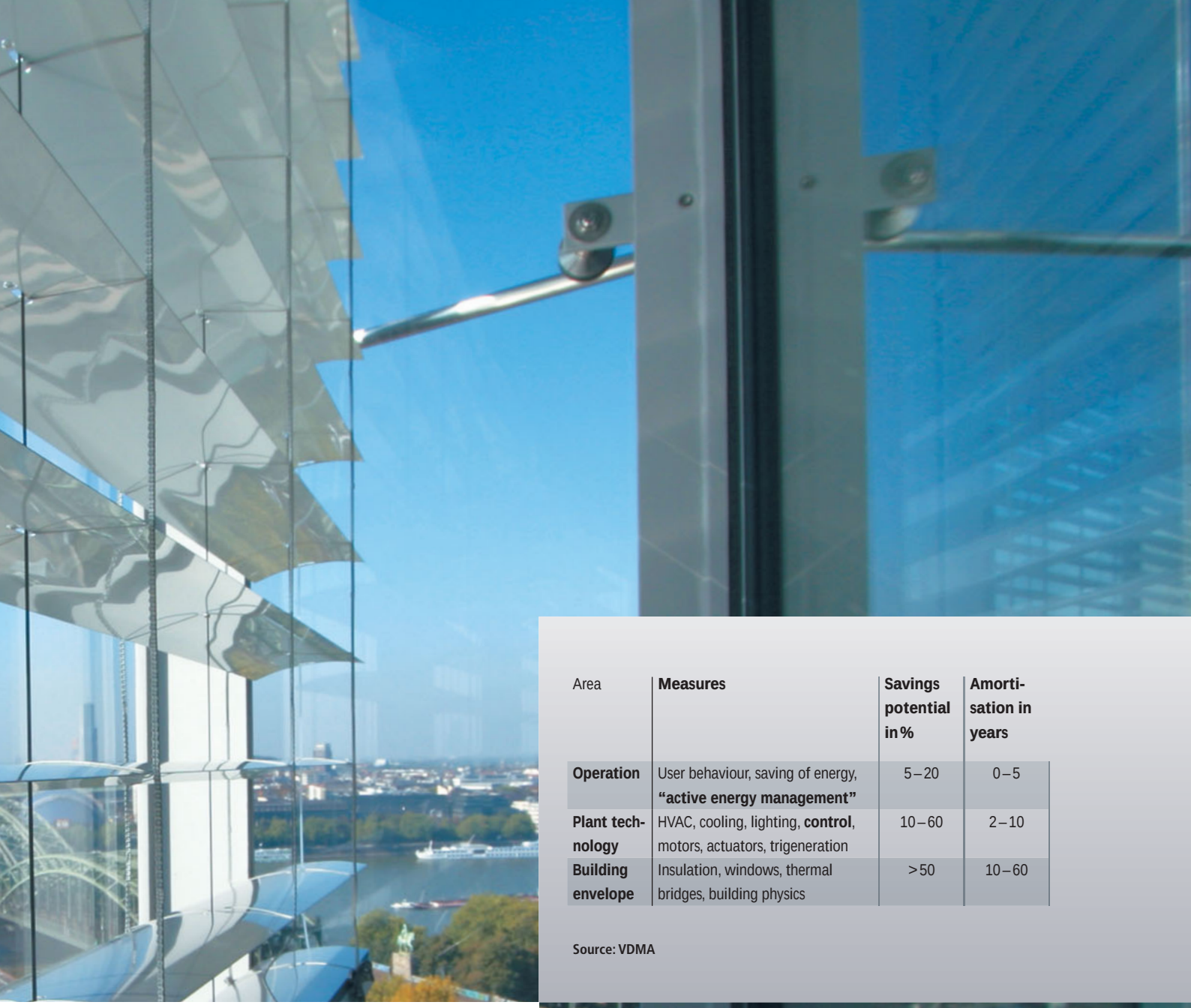

Area	**Measures**	**Savings potential in %**	**Amortisation in years**
Operation	User behaviour, saving of energy, **“active energy management”**	5 – 20	0 – 5
Plant technology	HVAC, cooling, lighting, **control**, motors, actuators, trigeneration	10 – 60	2 – 10
Building envelope	Insulation, windows, thermal bridges, building physics	> 50	10 – 60

Source: VDMA

specifically to optimise efficiency. Whether lighting or facade, air conditioning or access are concerned: all building systems are co-ordinated with one another and finely tuned – the possibilities of continuous system optimisation ensure the maximum possible reduction of the energy consumption. In combination with the inexpensive implementation, these savings give rise to two key benefits: firstly, the possibility of particularly fast amortisation (see table on the right) – in comparison with other energy efficiency investments. And secondly, reliable future security: with building automation from Beckhoff, it is possible to retrofit at a later time if required.

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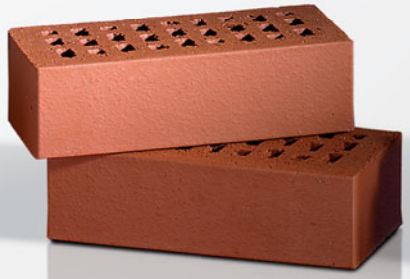
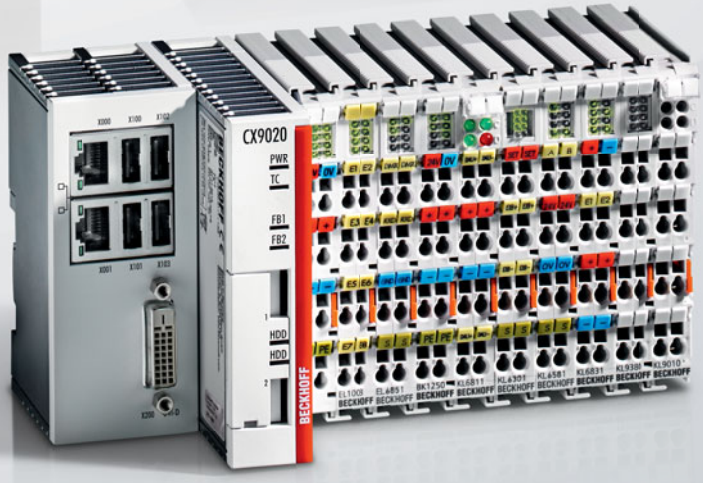
How to build flexibly:
with concrete.



How to build traditionally:
with bricks.

How to build safely:
with steel.



How to build intelligently:
with automation components from Beckhoff.

Energy efficiency is the no. 1 criterion. But it is not the only one.

The ecological requirements of a building are always identical: it is necessary to achieve the maximum energy conservation, to reduce emissions of gases that are harmful to the climate and, in addition to meeting legal requirements, to do justice to various certification methods (DGNB, LEED, BREEAM, Green Building, etc.). That is where the similarities end, however, because the requirements of the automation solution of a building are defined by three individual parameters: its location, the way it is used and its specific design. No two buildings are identical. Each software-based Beckhoff control solution is therefore tailor-made to meet the specific requirements. But that is not all: extensions or changes of function are possible at any time for all building systems on account of the predefined modular software components. And so that such an integrated solution is sustainable, with Beckhoff you can rely not only on the technology, but also on it being available to you over the entire life cycle of the building.

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To put it briefly: with a control solution from Beckhoff you not only implement maximum energy efficiency, but also

- **Economy/independence:** The open Beckhoff control architecture meets all technical and economic requirements.
- **Availability:** The Beckhoff technology is available on a long-term basis and offers investment security.
- **Universality:** With Beckhoff, all data points in a system are integrated.
- **Flexibility:** Variably combinable software modules ensure optimum individual adaptation.

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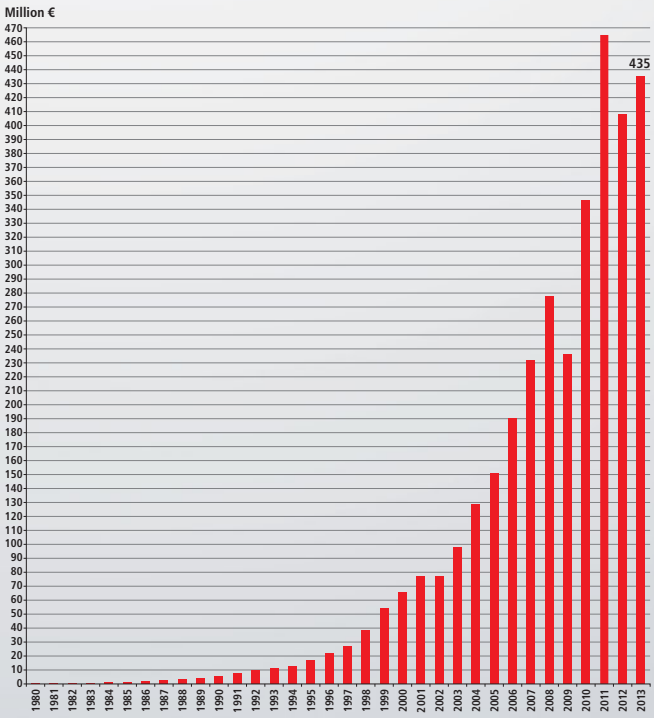

Turnover development

Beckhoff. Worldwide specialist for New Automation Technology.

Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries. The Beckhoff "New Automation Technology" philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.

▶ **www.beckhoff.com**

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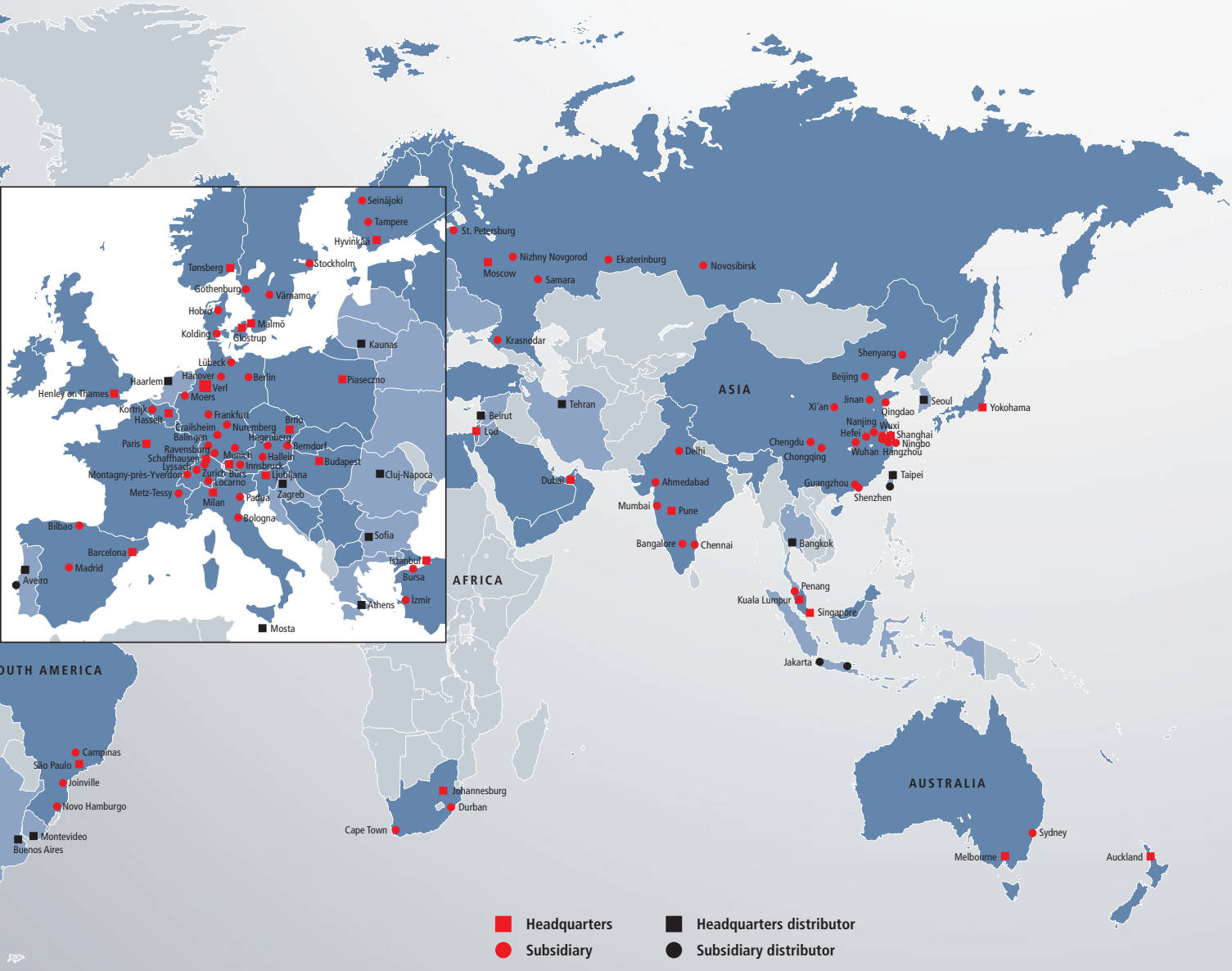

The central divisions of Beckhoff, such as development, production, administration, distribution, marketing, support and service, are located at the Beckhoff Automation GmbH headquarters in Verl, Germany. Rapidly growing presence in the international market is ensured by 30 subsidiaries. Through worldwide co-operation partners, Beckhoff is represented in more than 60 countries.

- Headquarters Verl, Deutschland
- Sales 2013: 435 Mio. €
- Staff worldwide: over 2.470
- Sales/Technical Offices: 11
- Subsidiaries/Branch Offices worldwide: 30
- Distributors worldwide: in more than 60 countries

(as of 04/2014)

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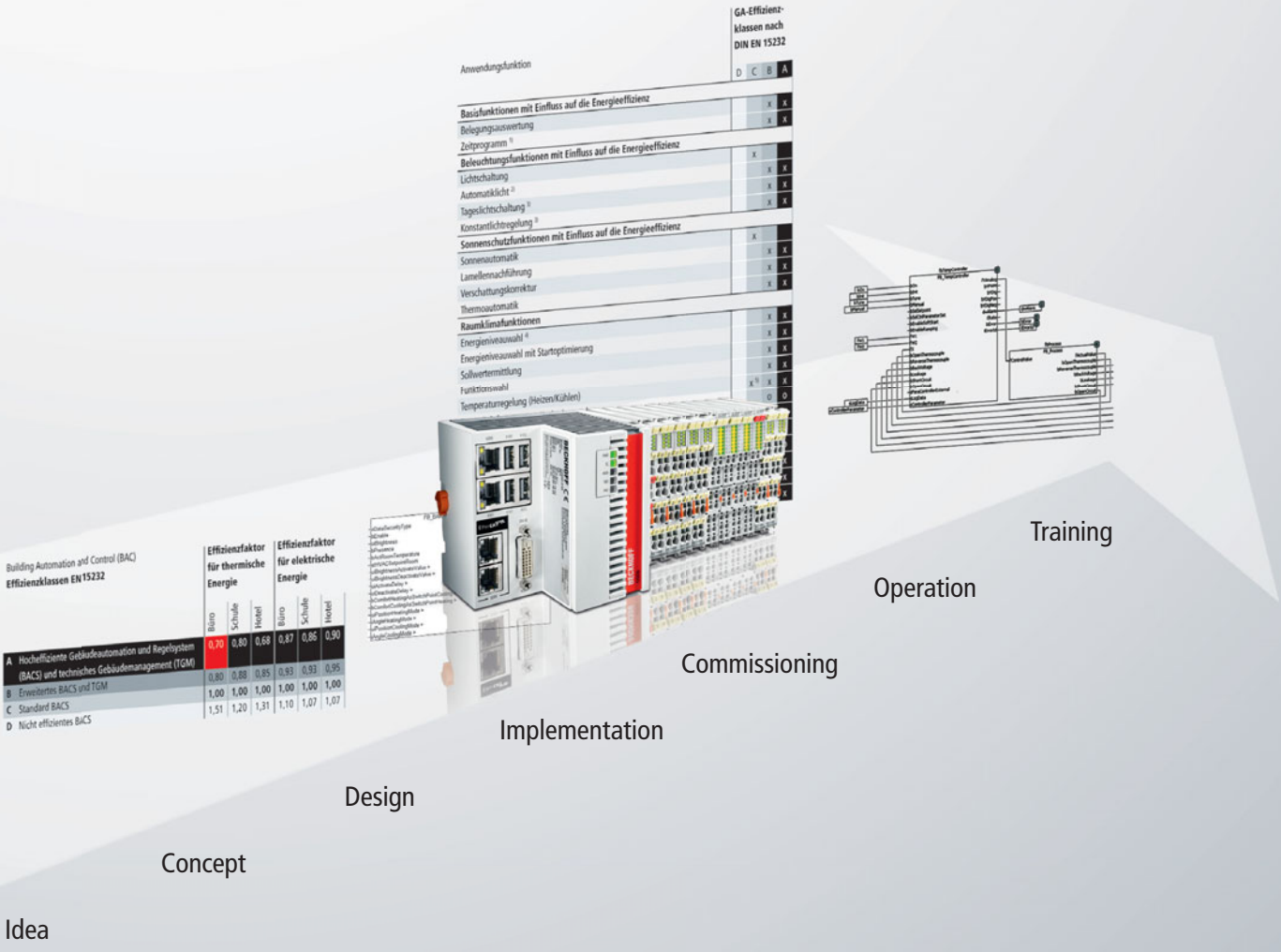

Implement a high-performance system: with Beckhoff.

A holistic building automation system from Beckhoff brings with it all the characteristics that are required for a high-performance system:

- The connection of all sensors and actuators of a building into one system requires a broadly diversified mix of the widest range of inputs and outputs: Beckhoff offers it.
- Computationally intensive building automation functions such as the correction of shading and the adjustment of blind lamellae have higher demands on the controller than in the past and therefore require a scalable, high-performance controller portfolio: like Beckhoff's.
- The load optimisation of the generators using room automation data, the connection of a building management system and the transmission of global data, such as from a

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weather station to the blind controllers in a building, requires fast and open communication: standard with Beckhoff.

- As the interoperability of the system increases, inter-disciplinary knowledge is required of all areas of the building's technical equipment: our specialists have this know-how.
- Having a consistent TwinCAT project file structure is a prerequisite for proper plant maintenance. The central underlying idea is our component identification system which assigns a name to each data point and program module in accordance with defined rules. The TwinCAT BA Project Builder from Beckhoff provides the solution.

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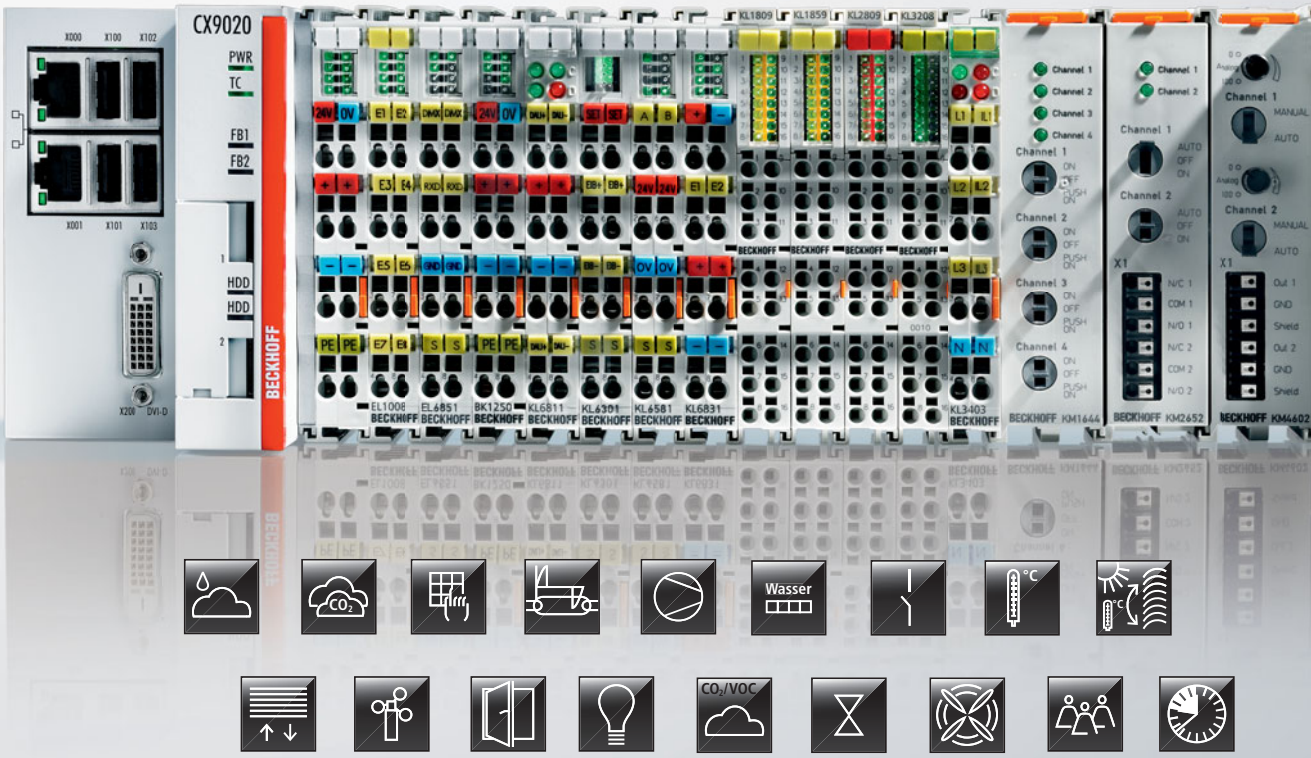

The components for intelligent building automation from Beckhoff.

Modular automation components.
The Beckhoff Bus Terminal system for connection of data points features 400 different I/O terminals and supports all common sensors and actuators. The fine granularity of the system allows only as many inputs or outputs to be plugged in as the project requires. The extremely high packing density (12 mm for 16 digital I/Os) reduces space requirements to a minimum and facilitates later upgrades. The Bus Terminal system is a worldwide automation standard and is used in numerous applications. Availability is thus guaranteed and provides high investment protection.

Scalable control technology.
The scalable, modular control system from Beckhoff offers a suitable solution for every task: from high-performance Industrial PCs for the management and control level, and compact Embedded PCs for the intermediate automation level to the Room Controller BC9191 for the field level. The high computing performance of PC-based control technology as well as the high industrial quality standard of all components has therefore proven itself not only with our industrial customers, but also in numerous building automation projects. The required computing power for building automation applications is often underestimated. PC-based Control offers adequate performance here. Examples: The synchronous positioning of all blinds in a facade requires a high speed of reaction. Likewise, a fast cycle time is demanded for synchronously positioning all blinds on a facade.

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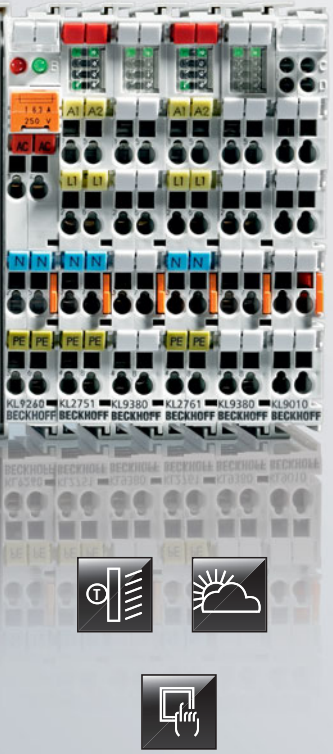

TwinCAT – efficient engineering
for all building systems

Open communication systems.
For the integration of our controllers into an existing automation topology, Beckhoff supports all of the communication protocols commonly used in the building automation market, such as:

- BACnet, OPC UA,
  Modbus TCP (automation level)
- DALI, DMX, EnOcean, LON, EIB/KNX, SMI
  MP-Bus, M-Bus, Modbus RTU (field level)

The Bus Terminal Controllers and PCs communicate right into the room automation level via an Ethernet network. This way, lower-level fieldbus technology is not necessary in many projects. Additional gateways for mapping the data from lower-level fieldbuses are therefore not required.

TwinCAT – efficient engineering for all building systems.
The programming or parameterisation of all systems takes place using TwinCAT automation software. The PLC is programmed in accordance with the IEC 61131-3 standard. Long-term access to adequately qualified technicians is required for the permanent safe operation of a building. Since the majority of controllers worldwide are programmed according to IEC 61131-3, the TwinCAT system is ideal for engineering in building automation. All programs are programmable in the same language and are available as function blocks in the building automation libraries. Life cycle costs are reduced, because the expenditure for maintenance concentrates on the same programming software.

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1980	1986	1995	1996	1999	2000	2002	2004
Foundation of the company	**First PC-based machine controller**	**Bus Terminal** fieldbus technology in terminal block format	**TwinCAT** real-time software PLC	**BC9000** Ethernet Bus Terminal Controller	**KL2722** sunblinds terminal	**CX10xx** Embedded PC **KL6811** DALI terminal	**KL6023** EnOcean wireless adapter

Milestones in building automation: Sustainable investments in Beckhoff technology components

Sustainability in terms of resource efficiency is one of the core features of any building automation system. Beckhoff extends the term even further by applying it to the actual components, because all new Industrial PCs (IPCs) from Beckhoff use only the latest and most powerful processors from renowned manufacturers. And since our product portfolio is subject to continuous innovation processes, you receive a solution that is not only state-of-the-art, but future-ready.

IPC technology from Beckhoff also delivers great benefits for renovation and expansion projects of existing buildings, because all our IPCs are backwards-compatible with older models. This makes it easy to replace older units, and existing programs can be migrated to the newest models without having to be modified. Installed Bus Terminals and/or I/O systems can stay in place.

The needs of building operators may frequently change over the life of a building automation system. For example, they might want to add the standardized BACnet communication protocol to an existing system. However, with many classic DDC (direct digital control) systems, this is not possible. The open design of PC-based control technology from Beckhoff, on the other hand, permits the installation of new features like the BACnet protocol even years after the system's

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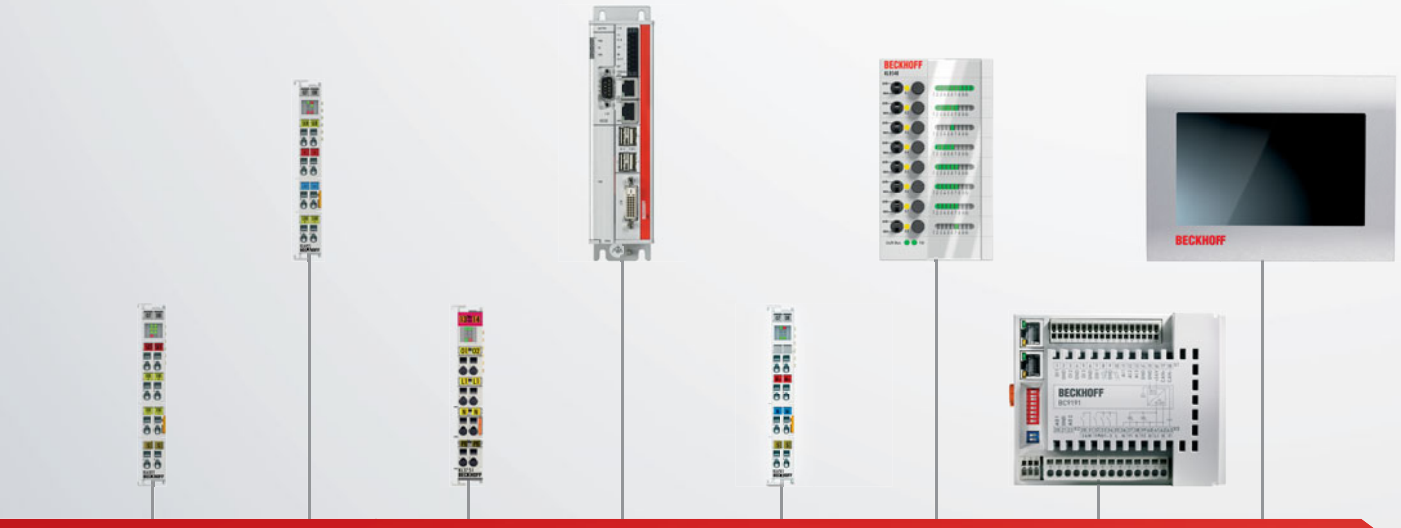

2005

KL6301
EIB/KNX terminal

2006

KL6771
MP-Bus terminal

KL6401
LON terminal

2007

TwinCAT HVAC library

KL2751
KL2761
dimmer terminal

2009

C6915
compact control cabinet IPC

CX50xx
CX90xx
Embedded PC

EL6851
DMX terminal

2010

KL6781
M-Bus terminal

2012

KL85xx
manual operating modules

CX8090
Embedded PC in Bus Coupler format

TwinCAT BACnet/IP

CP2xxx
built-in multi-touch Control Panel

2013

BC9191
BA Room Controller

CX9020
Embedded PC

2014

TwinCAT Building Automation

KL6831, KL6841
SMI terminal

CP6606
built-in Panel PC

CX8091
Embedded PC for BACnet/OPC UA

initial commissioning without having to install a new Industrial PC.

The modular building automation portfolio consisting of processors available in a range of performance classes, Windows operating systems and TwinCAT software libraries makes it possible to adapt Industrial PCs to changing building requirements for many years to come. Another sustainability feature of the Beckhoff solution is the long-term availability of the Bus Terminal system. It has been on the market for almost 20 years, and with now more than 400 signal types it has become one of the world's most successful and comprehensive I/O systems. Its modular design also makes it easy to replace individual Bus Terminals or to make add-ins.

And should end users want to replace their Beckhoff IPCs with other controllers, this is possible as well. The wide range of available fieldbus couplers lets you link Bus Terminals to DDC or control systems from other manufacturers via Modbus, PROFIBUS or other protocols. Thus, customers can combine Beckhoff components with products from any vendor and enjoy a high degree of investment protection for existing I/O units.

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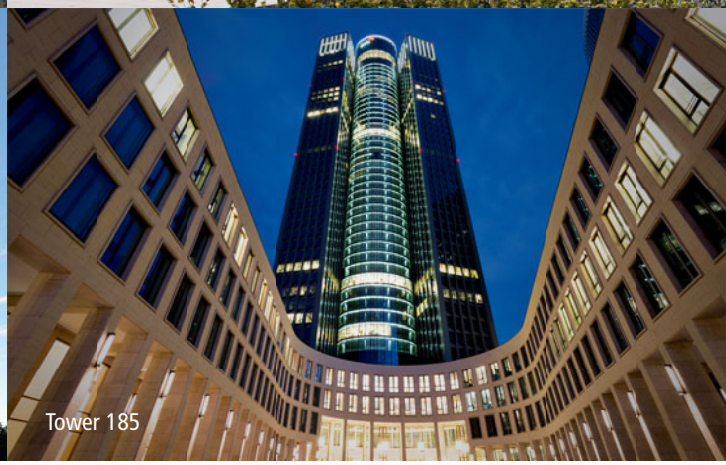
Schüco Technology Center

Eurotheum (European Central Bank)

KölnTriangle

Zayed University

KEA – Copenhagen School of Design and Technology


Tower 185

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Microsoft Cologne

Intelligent office buildings, schools and universities: with Beckhoff.

- Allianz head office, Stuttgart, Germany
- BSH Bosch und Siemens Hausgeräte GmbH at "Aviva", Munich, Germany
- Campus Dornbirn, Dornbirn, Austria
- Etech-Center/AMS Engineering, Linz, Austria
- Eurotheum (European Central Bank), Frankfurt am Main, Germany
- Fortis Bank, Brussels, Hasselt, Belgium
- KEA – Copenhagen School of Design and Technology, Copenhagen, Denmark
- KölnTriangle, Cologne, Germany
- Microsoft, Cologne, Germany
- Microsoft, Unterschleißheim near Munich, Germany
- Nordea Bank, Oslo, Norway
- Office building "Esplanade" Theresienhöhe, Munich, Germany
- Schüco Technology Center, Bielefeld, Germany
- Tower 185, Frankfurt am Main, Germany
- WesBank, Johannesburg, South Africa
- Westpac headquarters, Sydney, Australia
- Widex A/S, Lynge, Denmark
- Zayed University, Abu Dhabi, United Arab Emirates
- Zukunftsmeile Fürstenallee, Paderborn, Germany

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dSPACE

Highly efficient: Beckhoff solutions for industry.

- AMAG Automotive, Buch, Switzerland
- BKN Strobel, Holm, Germany
- Broschek Tiefdruck, Hamburg, Germany
- Daimler, Stuttgart, Germany
- dSPACE, Paderborn, Germany
- F-eins, Vienna, Austria
- Heroal, Verl, Germany
- Liebherr Werk, Nenzig, Austria
- Miele, administration building for electronics development, Gütersloh, Germany
- New Energy Research Institute, Beijing, China
- Philip Morris International, Lausanne, Switzerland
- SOLON SE, Berlin, Germany
- ZF-Lemförder Fahrwerktechnik, Dielingen, Germany

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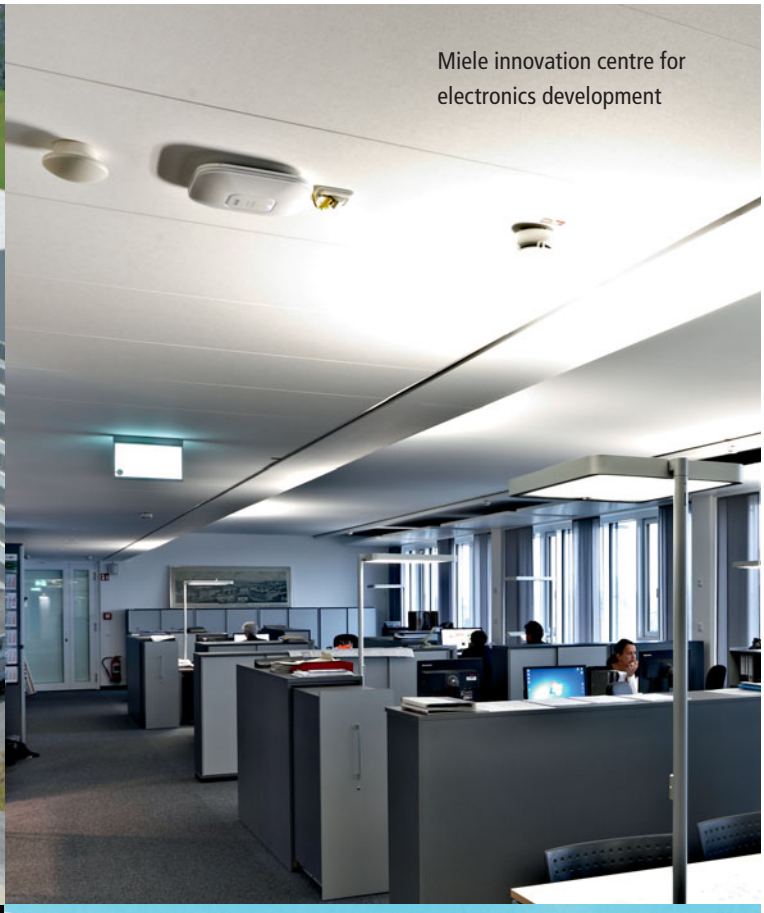
AMAG Automotive



Miele innovation centre for electronics development

F-eins

New Energy Research Institute

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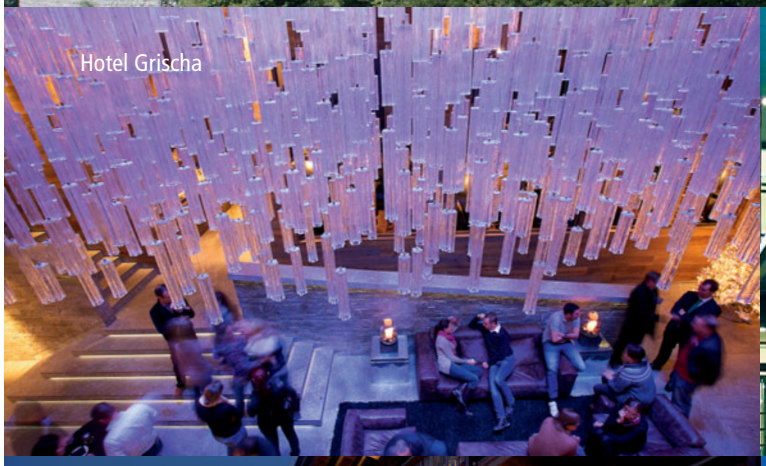

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Parkhotel Vitznau

Satisfies the highest demands: Beckhoff in hotels.

- AquaDom – Radisson Blu Hotel, Berlin, Germany
- CitizenM Hotel, Amsterdam, Netherlands
- Dolder Grand Hotel, Zurich, Switzerland
- Grand Tirolia, Kitzbühel, Austria
- Holiday Inn, Samara, Russia
- Hotel Aurelio, Lech, Austria
- Hotel Aviva, St. Stefan am Walde, Austria
- Hotel Krallerhof, Leogang, Austria
- Hotel Rasmushof, Kitzbühel, Austria
- Hotel Sonne, Mellau, Austria
- Leonardo Royal Hotel, Munich, Germany
- Park Hotel Vitznau, Switzerland
- Royal Spa Kitzbühel, Austria
- St. Martins Therme, Frauenkirchen, Austria
- Therme Laa, Laa an der Thaya, Austria
- Tschuggen Bergoase, Arosa, Switzerland
- Zirbenhütte, Fiss, Austria

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Helsinki Music Hall

The stage for the cultural industry: Beckhoff in theatres and museums.

Theatres

- Carré Theatre, Amsterdam, Netherlands
- Helsinki Music Hall, Helsinki, Finland
- Janacek Theatre, Brno, Czech Republic
- Ronacher Theater, Vienna, Austria
- Scala di Milano, Milan, Italy
- Schauspielhaus Nürnberg, Germany
- Sibelius Hall, Lahti, Finland

Museums

- Charlottenburg Palace, Berlin, Germany
- Deutsches Museum, Munich, Germany
- Dresdener Stadtmuseum, Dresden, Germany
- Sisi-Museum, Wiener Hofburg, Vienna, Austria

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Charlottenburg Palace

Scala di Milano

Deutsches Museum

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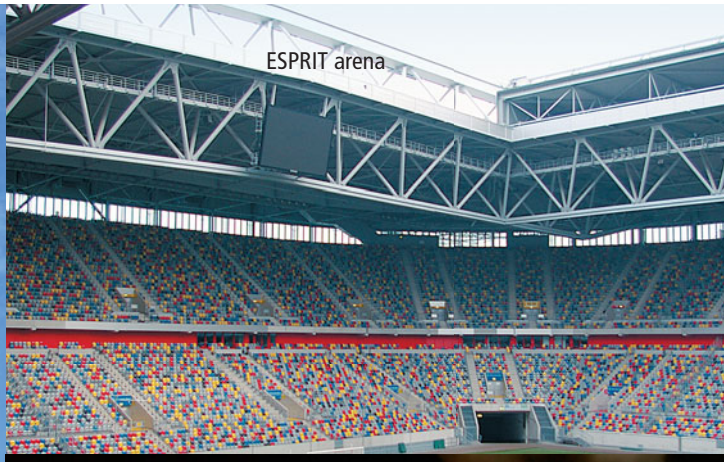
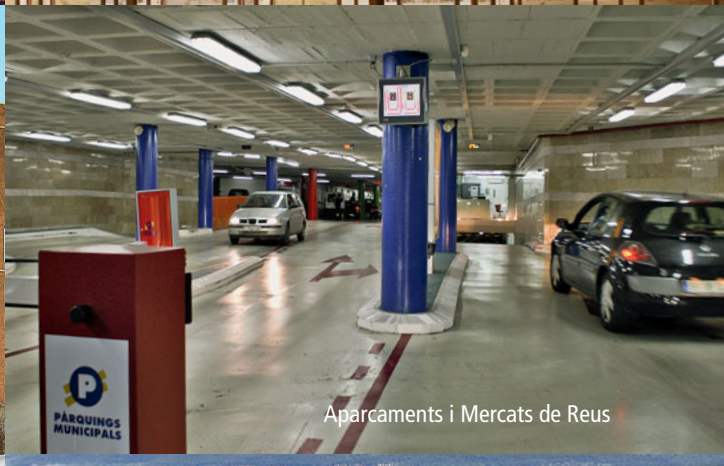
KLIA 2 Control Tower


ESPRIT arena

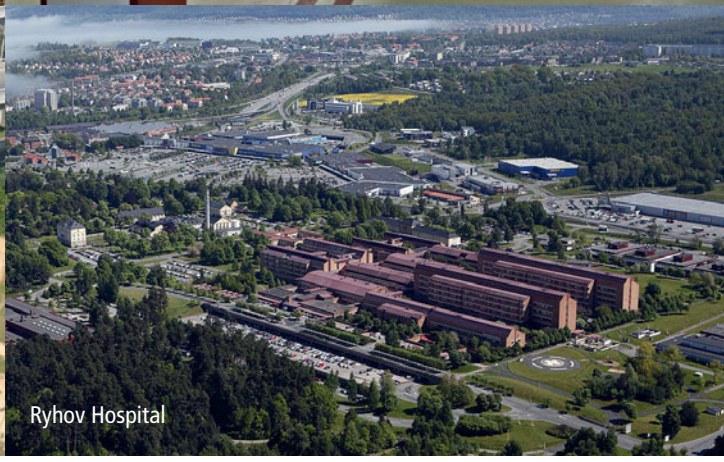
Oncological Center

Oslo City Hall



Aparcaments i Mercats de Reus

Nordtangente Basel


Ryhov Hospital

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Ferry Porsche Congress Center

Contemporary: infrastructural building automation from Beckhoff.

- Allianz Arena, Munich, Germany
- Aparcaments i Mercats de Reus, Reus, Spain
- AUA Training Center, Schwechat, Austria
- ESPRIT arena, Düsseldorf, Germany
- Europlaza, Vienna, Austria
- Ferry Porsche Congress Center, Zell am See, Austria
- Gran Casino Aranjuez, Madrid, Spain
- Lufthansa Training Center, Schwechat, Austria
- KLIA 2 Control Tower, Sepang, Malaysia
- Metro M2, Lausanne, Switzerland
- Nordtangente (ring road north), Basel, Switzerland
- Oncological Center, Samara, Russia
- Oslo City Hall, Oslo, Norway
- Ryhov Hospital, Jönköping, Sweden
- Stadtwerke Lingen, Germany
- Steelworks, Bremen, Germany
- Zentrum Zukunft, Emstek, Germany
- Zigong City Tower, Zigong, China

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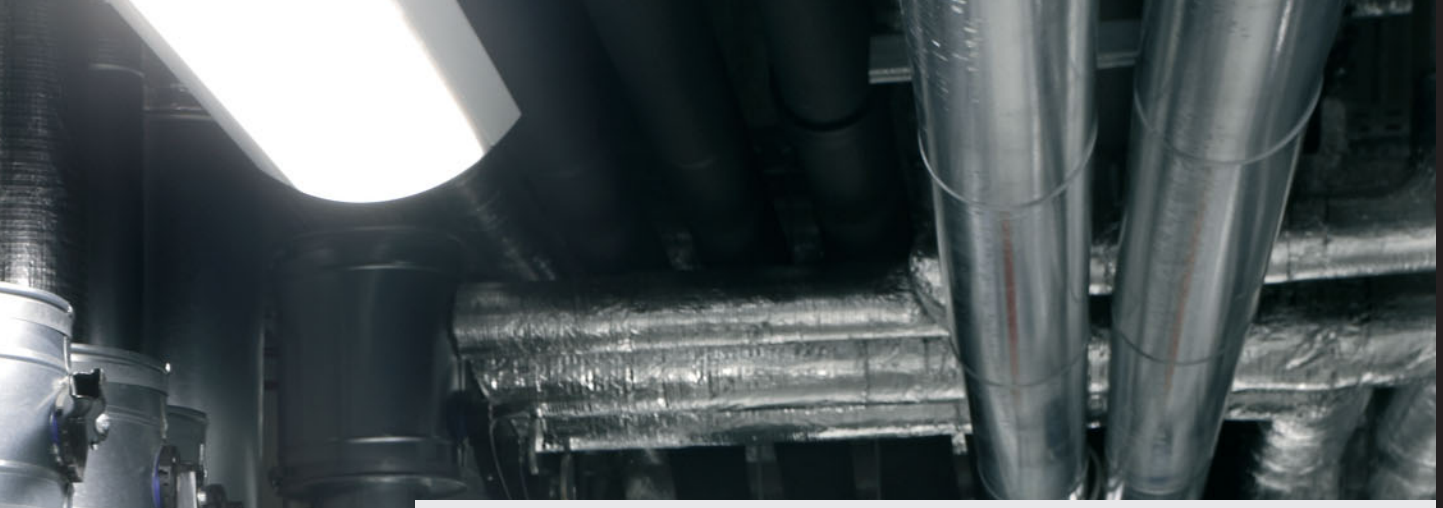
Heizung Vorlauf
Heizung Vorlauf



Planning | Building systems | Solutions for planners and technicians

Application of the latest norms and standards gives rise to new possibilities for the planning of new buildings and the renovation of existing stock. Good cooperation between the different fields represented by specialist planners, architects, builders, commissioning engineers and operators can considerably improve the ecological and commercial value of a building. An energy efficient, integrated building automation system can only be implemented with the use of one control system for all technical building systems.

Section 1 — 02 Industrial Building Automation

Section 2 — Planning I Building systems I Solutions

28 Basic principles and standards of building automation
31 Use in room automation
34 Open control technology
36 System topology
38 Integrated building automation
44 Room automation, offices
48 Room automation, hotels
52 Automation of industrial buildings
56 Central HVAC system
60 Remote maintenance

Section 3 — 62 Product data

Basic principles and standards of building automation

In recent years, standards for building and room automation have been set by international committees to make the functionalities of building automation measurable and to be able to implement them efficiently. The energy efficiency of a building describes the relationship between the energy used and the resulting benefit. The latter must always be seen in relation to the function of a building and is an important factor in the evaluation of energy efficiency.

DIN EN 15232: energy efficiency of buildings

European norm EN 15232 describes the effect of building automation and building management on energy efficiency and enables standardised representation for the first time. It includes a structured list of all building automation functions that can affect the energy efficiency of a building. It also offers systematic support for the definition of minimum requirements concerning building automation. The following can be stated as a basic principle: the higher the level of automation, the greater the energy savings.

Equivalent to highly energy-efficient BAC systems and TBM	A
Equivalent to more advanced BAC systems and some special TBM functions	B
Equivalent to standard BAC systems	C
Equivalent to BAC systems that are not energy-efficient. Buildings with such systems must be modernised. New buildings must not be constructed using systems such as these.	D

Building Automation and Control System (BAC), Technical Building Management (TBM)

We reserve the right to make technical changes.

The table illustrates the relationship between building automation functions and energy efficiency classes for control of the heating system.

	Automatic control and regulation of the heating system	Definition of classes							
		Residential building				Non-residential building			
		D	C	B	A	D	C	B	A
Control of transfer									
	The controller is installed at transfer level or room level; in the former case, one controller can regulate a number of different rooms.								
0	No automatic control	x				x			
1	Central automatic regulation	x	x			x			
2	Automatic individual room control using thermostatic valves or electronic control devices	x	x			x	x		
3	Individual room control with communication between control devices and BACs	x	x	x		x	x	x	
4	Integrated individual room control including needs-based regulation (occupancy, air quality, etc.)	x	x	x	x	x	x	x	x
Regulation of hot water temperature in distribution network (flow or return)									
	Comparable functions can be used to control networks for direct electrical heating.								
0	No automatic control	x				x			
1	Weather-based control	x	x			x	x		
2	Control of inside temperature	x	x	x	x	x	x	x	x
Control of circulation pumps									
	The controlled pumps can be installed in the network at different levels.								
0	No control	x				x			
1	On/off control	x	x			x			
2	Control of variable pump speed according to a constant Δp	x	x	x	x	x	x	x	x
3	Control of variable pump speed according to proportional Δp	x	x	x	x	x	x	x	x
Control of transfer and/or distribution during intermittent operation									
	One controller can regulate different rooms/zones with the same occupancy pattern.								
0	No automatic control	x				x			
1	Automatic control with fixed time program	x	x			x			
2	Automatic control with optimised on/off switching	x	x	x	x	x	x	x	x
Control of generators									
0	Constant temperature	x				x			
1	Variable temperature dependent on the outside temperature	x	x	x	x	x	x	x	x
2	Variable temperature dependent on the load	x	x	x	x	x	x	x	x
Operating sequence of different generators									
0	Priority setting based solely on the load	x	x			x	x		
1	Priority setting based on the load and on the generator performance	x	x	x		x	x	x	
2	Priority setting based on the level of generator usage (check other norms)	x	x	x	x	x	x	x	x

Source: DIN EN 15232

We reserve the right to make technical changes.

Application of EN 15232 gives rise to different energy efficiency factors for different building types, with regard to the use of thermal and electrical energy. In the evaluation of buildings, the energy efficiency class C is the reference class for the implementation of measures for energy optimisation.

The red field in the table on the right-hand side shows how the thermal energy consumption of a building with efficiency class A with a factor of 0.7 can be reduced by up to 30 %.

Building Automation and Control (BAC) **Efficiency classes EN 15232**		**Efficiency factor for thermal energy**			**Efficiency factor for electrical energy**		
		Office	School	Hotel	Office	School	Hotel
A	Highly efficient Building Automation and Control System (BACS) and Technical Building Management (TBM)	0.70	0.80	0.68	0.87	0.86	0.90
B	Advanced BACS and TBM	0.80	0.88	0.85	0.93	0.93	0.95
C	Standard BACS	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
D	Non-efficient BACS	1.51	1.20	1.31	1.10	1.07	1.07

Source: DIN EN 15232, table 9, table 11

VDI 3813 – room automation

VDI 3813 describes the integrated room automation with special consideration for interoperability of different building systems, based on usage requirements. To provide a uniform assessment basis for owners, planners and system integrators, clear terms and functions are defined in the norm.

The current difficulty is that in invitations to tender, room automation functions are dealt with separately from the building systems connected with technical development. In practice, this often means that existing potential for saving energy remains unused.

The VDI 3813 supplements the EN 15232 by providing a precise description of the room automation functions described there. It is important that EN 15232 and VDI 3813 are applied as early as the basic evaluation and pre-planning stage.

The table on the right-hand side shows the room automation functions of the VDI 3813, relating to the energy efficiency classes of EN 15232.

Application function	**BAC efficiency classes in accordance with DIN EN 15232**			
	D	C	B	A
Basic functions affecting energy efficiency				
Occupancy control			x	x
Time program			x	x
Illumination functions which influence energy efficiency				
Light switching		x		
Automatic lighting			x	x
Daylight switching			x	x
Constant light control			x	x
Solar shading functions which influence energy efficiency				
Automatic solar shading		x		
Louvre adjustment			x	x
Shading correction			x	x
Thermo-automatic control			x	x
Air conditioning functions				
Energy level selection			x	x
Energy level selection with start optimisation			x	x
Target value calculation			x	x
Function selection			x	x
Temperature control (heating/cooling)		x	x	x
Room/intake air temperature cascade control			x	x
Ventilator control			x	x
Sequence control			x	x
Setpoint control			x	x
Air quality control/regulation				x
Night cooling			x	x
Load optimisation			x	x

Source: VDI 3813 part 2

We reserve the right to make technical changes.

Use in room automation

In room automation, sensors are implemented depending on their function and not on the individual building system. This saves on hardware and cabling costs as early as in the system installation phase. The reduction in cabling also has a positive spin-off effect on fire loads and building statics.

To achieve energy efficiency class A in accordance with EN 15232, Beckhoff offers a software library based on room automation guideline VDI 3813.

Comprehensive room automation exploits the interdependencies of facade control, illumination and climate control to create a pleasant room climate. At the same time, efficient room and zone control also affects the primary systems: the heating and cooling requirements and the air quantities are regulated according to need. When designing the heating, cooling, ventilation and air conditioning systems, the needs arising from the specific use of the building must be taken into account. A further benefit lies in the way in which a majority of the optimisation functions can be realised within the software on a single system during commissioning and ongoing operations. As a result, no reconstruction work impedes operation and the time required for software adjustment also remains within reasonable limits. In certain cases, many modifications can be made by accessing the system remotely, without the need for a service technician to attend in person.

The adjacent matrix shows the interplay of the individual building systems with regard to the sensors used. For energy efficient automation, all individual building systems must be controlled and managed from a single system.

Interaction of building systems	**Sensor system**					
	HVAC	Lighting	Solar shading	Security	Global	Monitoring
Light intensity	x	x	x			
Room temperature	x		x			x
Occupancy	x	x	x	x		x
Window contact	x		x	x	x	
Room operating device	x	x	x			
Weather (wind/rain)			x		x	
Outside temperature	x		x		x	
Solar radiation	x	x	x		x	

Offices according to energy efficiency class A

For a better illustration of what lies behind building automation functions and how energy can be saved, examples of building automation functions in an office with energy efficiency class A are described below.

Technical equipment of an office

Illumination consists of one lighting strip on the corridor side and one on the window side. The lights are held at a constant room brightness level via DALI (constant light control), depending on the amount of daylight. A room brightness sensor is mounted in the ceiling. An occupancy sensor is installed for needs-dependent management and control of the entire room.

The office is shaded by means of two electrically operated, externally mounted louvre blinds. Two buttons are installed for manual control of the blinds.

To heat the room, a radiator is present. The office is cooled via a cooling ceiling. An actuator is located on the radiator and on the cooling ceiling respectively. The room temperature is monitored and the desired room temperature is adjusted locally using EnOcean radio technology.

For ventilation, the office is connected to an air-conditioning installation. Volume flow is variable. The open state of the window is captured via a digital input; so too is the dew point sensor on the cooling ceiling.

Heating/cooling function

To minimise energy use for room heating and cooling, the desired room temperature is determined via a scheduler-dependent energy level selector (see fig. 1, page 30, and fig. 2, page 31). In the case of long absences, e.g. during shut-down periods, the office is switched to "Protection", the lowest energy level, to prevent damage caused by frost or overheating. For brief absences, e.g. at night or on weekends, the office is set to "Economy" mode. Only at the start of core working time is the energy level raised to the level "Pre-Comfort". The room temperature is now almost up to the comfort target value. Only when persons are detected in the room is "Comfort" mode activated and the appropriate set value reached in a short time.

The system switches from "Economy" to "Pre-Comfort" mode as late as possible via the energy level selector with start optimisation. The optimum activation time is calculated by the building automation system.

The opening of the window is monitored by a window contact. If the window is open, the system automatically switches to the "Protection" energy level. This automatically stops unnecessary energy consumption due to a window being opened.

The room temperature set values for all four energy levels are provided by the room climate function set value calculation for heating and cooling.

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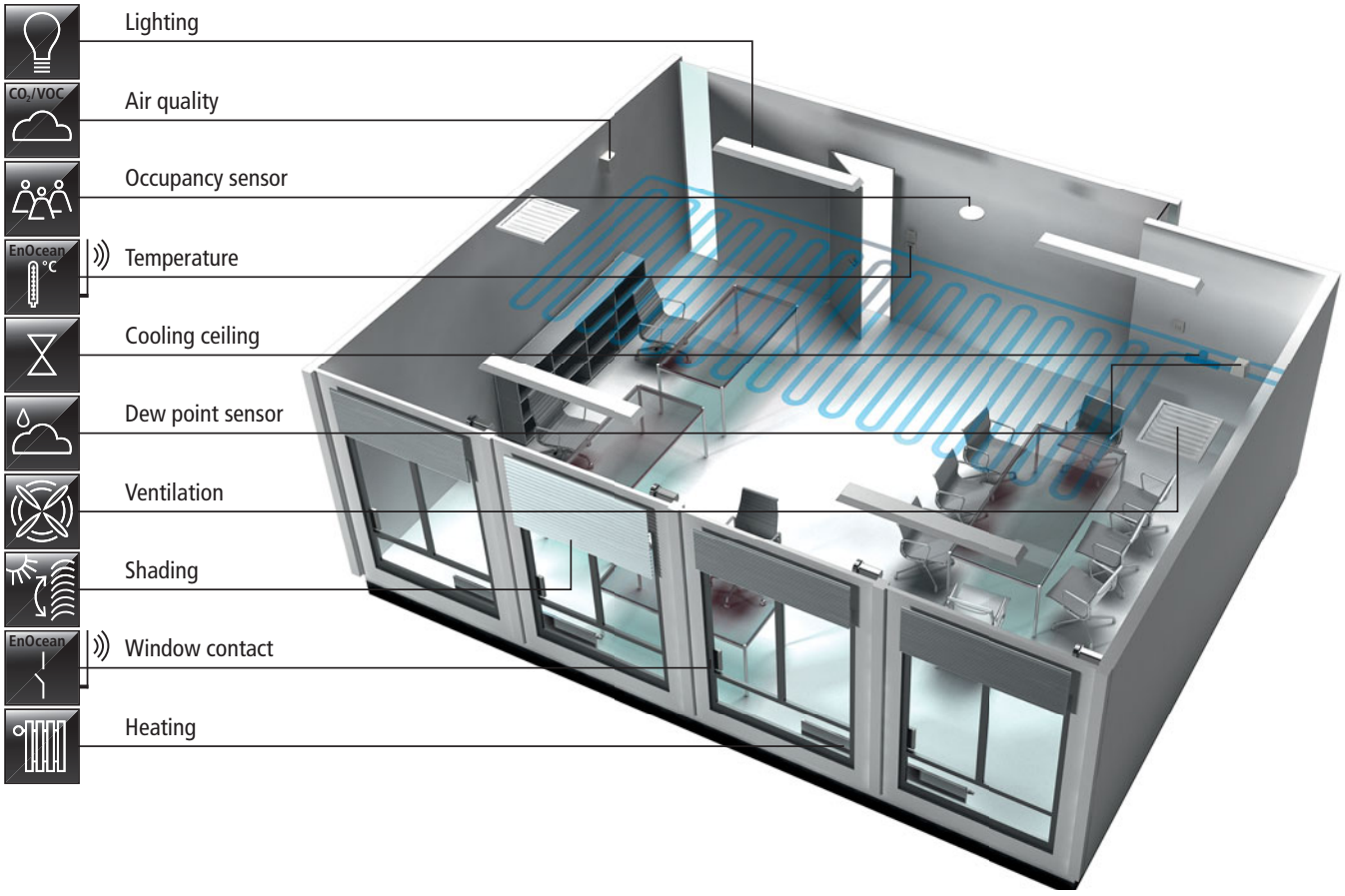

The "Function Selection" function regulates the controller for heating and cooling and compares the current room temperature against the set value. If the current value is lower than the target value for the energy level "Comfort" heating, the heating controller is activated. If the current room temperature is higher than the set value for the energy level "Comfort" cooling, the cooling controller is activated. Simultaneous heating and cooling is not possible.

Ventilation

In summer, natural cooling at night helps reduce energy consumption: The night cooling program switches on the room ventilation system and ventilates the offices using cool external air. This removes heat from the building at night so that less energy is required to cool the room the following day. For electrically operated windows, these can also be used for automatic night cooling in summer.

Load optimisation

Communication between systems for automation of energy centres and systems for the generation and distribution of heating and cooling water enables needs-based adjustment of the flow temperatures. This allows transfer losses to be minimised and the overall effectiveness of the systems to be increased.

Air quality regulation

Depending on the measured air quality, the volume flow controller is used to introduce more or less fresh air into the room. If the air quality is good, air intake is reduced to a minimum volume flow. The central air conditioning unit for ventilation automatically adjusts the level of ventilation based on the data communicated between the room automation system and the primary systems. This reduces the energy consumption of the fans by up to 45 %. In the event of zero occupancy, the volume flow is reduced to a minimum.

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Shading: thermo-automatic control and shading correction

Constant light control

If a minimum light strength in the room is not reached but the room is occupied, the constant light control function switches on automatically. Conversely, if the amount of external light increases, the proportion of artificial light automatically reduces or is switched off once a suitable lighting strength is reached. If the occupancy detector identifies that the room is empty, the constant light control function switches itself off on a time-delay basis.

Shading

Control of solar shading is integrated directly into the room automation system. The "thermo-automatic" function supports the heating and cooling function of the room if it is not occupied. To benefit from sun light in winter, solar shading is raised to help heat the space using the sun's rays. In summer, the solar shading is automatically activated to reduce the energy yield from the sun and to assist cooling.

If the room is occupied and the sun is shining in strongly, the solar shading is automatically activated. The louvre adjustment optimises the angle of the louvre according to the position of the sun. The blades are positioned in such a way as to prevent blinding from direct sunlight while keeping the need for artificial lighting to a minimum in order to reduce energy consumption.

The shading correction function calculates the shadow movement on the facades of the building, depending on the position of the sun, the facade orientation and the position and coordinates of the surrounding buildings that provide shade. This prevents unnecessary activation of the solar shading and increased energy consumption due to the use of artificial light within the building.

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We reserve the right to make technical changes.

Open communication

The use of standardised protocols such as BACnet/IP and OPC UA ensures investment protection through vendor-independence.

The use of Ethernet cabling right down to field level provides a transparent network for commissioning and maintenance, and depending on requirements, the relevant IP-based protocol can be used for communication on this network.

BACnet/IP

The international BACnet standard, which ensures the interoperability of building automation and control devices from different manufacturers, is growing in popularity and is being constantly enhanced with new functions. BACnet/IP can be used on all PC-based Beckhoff hardware platforms – down to the field level – as a universal Ethernet protocol. The rail-mountable Embedded PC models CX8091, CX9020, CX5010 and CX5020 are certified for the ISO 16484-5:2010 Rev. 12 BACnet standard and feature a powerful control platform ranging from the CX8091 with support for 250 data points to the CX5020 which can collect and process several thousand BACnet objects.

And since the BACnet protocol is integrated into the TwinCAT System Manager, the I/O Bus Terminals and BACnet devices are easily configured via the tool-based automapping function. BACnet servers and clients can be installed in a structured manner so that the BACnet properties can be easily linked to the PLC as parameters and process data. In addition, the ability to access BACnet data via a non-cyclical interface makes it easy to implement visualisation components. Another feature is the dynamic generation of BACnet objects, which makes it possible to subsequently generate and configure schedules and trend objects. Distributed clocks can be synchronised with the supported client and master functions, and even automatic summer and winter time adjustments can be implemented with the integrated operating system functionality. Since hardware status monitoring has been integrated into the BACnet/IP implementation, it is available to all BACnet/IP applications without additional effort, too. The advanced alarm and event services, additional object types, improved device management features and increased execution performance of BACnet Rev. 12 are also implemented in TwinCAT BACnet/IP and add to the user benefits.

Since the Beckhoff solution was developed completely in-house, users can be confident that the company has plenty of expertise in the field.

OPC Unified Architecture (UA)

OPC UA is gaining acceptance on all levels of the automation pyramid. Its scalability ranges from small 15-kB footprint applications in tiny embedded sensors to communication with ERP level and SAP systems right up into the cloud. OPC UA has its origin in automation technology, but its industry-neutral nature makes it increasingly popular as a consistent communication platform in building automation and smart metering applications.

Since OPC UA can be used as both server and client, the traditional "top-down" direction of the communication flow becomes increasingly immaterial. While "OPC classic" was based exclusively on Microsoft's COM/DCOM technology, OPC US is independent from the operating system and language as well as scalable from the sensor to the ERP/cloud level. Security-by-design provides user authentication, message signing and data encryption already in the OPC UA stack. And its modelling of information sources makes OPC UA particularly interesting for other organizations, who can organize their existing objects in the UA name space and define "What is being communicated" while OPC UA manages transport security and access rights by asking "How is it being communicated?". OPC UA is currently the only IEC standard-based SOA technology that features semantic interoperability. Besides PLCopen, the BACnet group also maintains a joint group with the OPC Foundation in order to provide BACnet objects in the OPC UA name space and create an easy link to administrative/ERP processes via OPC UA.

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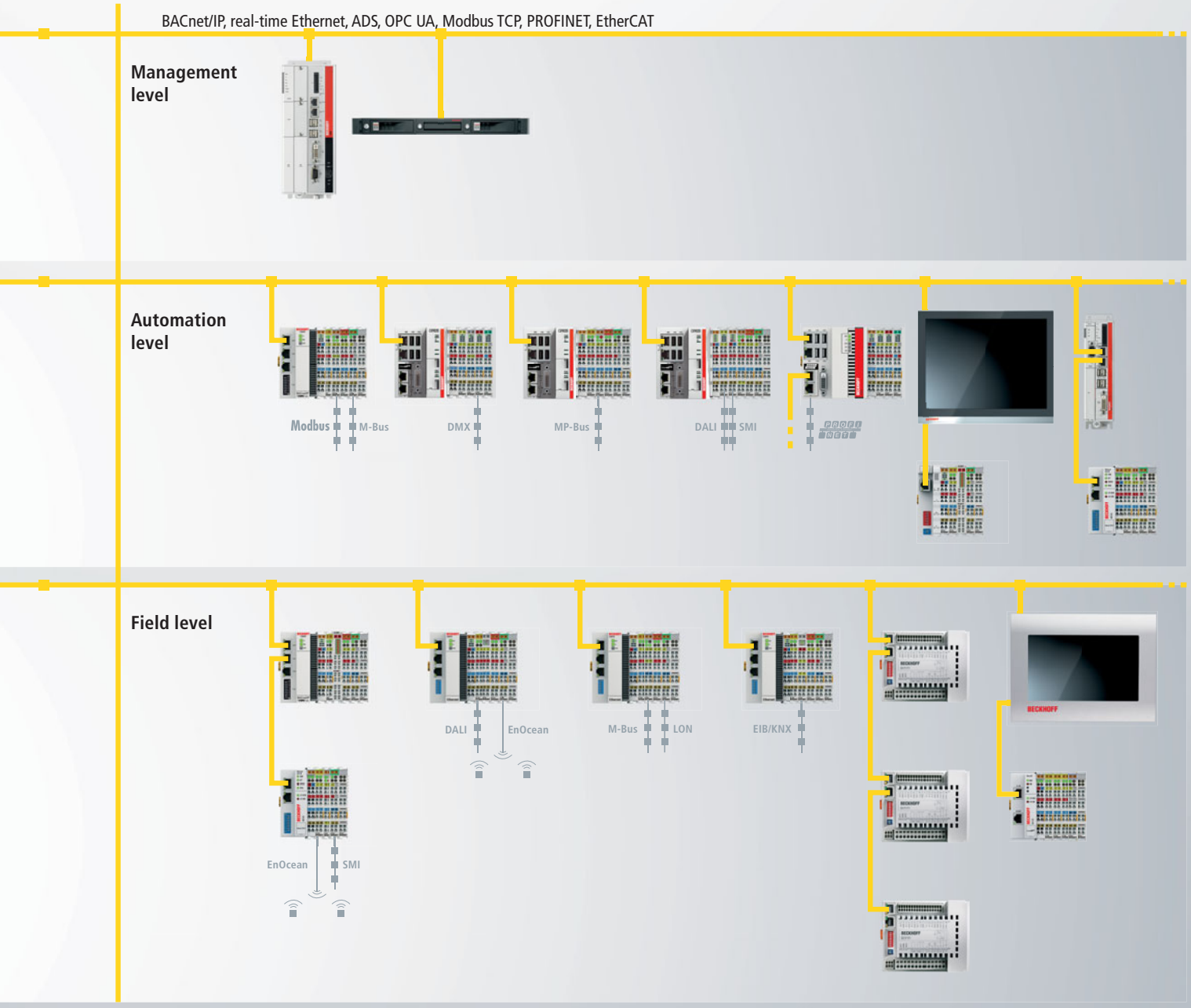
System topology



Depending on the way they are being used, buildings have different levels of control requirements. To meet these requirements, Beckhoff's automation portfolio includes "head stations" in various performance classes which allow you to scale the control platform in line with the respective performance requirements. Since all controllers are freely programmable, you can develop a uniform control concept for the different requirements of each system component.

And if you need to extend the system, you can simply replace the head station without having to make major changes in the application program. The use of decentralised Web servers on Industrial PCs and Embedded PCs also allows easy access to different system components. Room controllers are available as compact solutions for room automation across different building systems.

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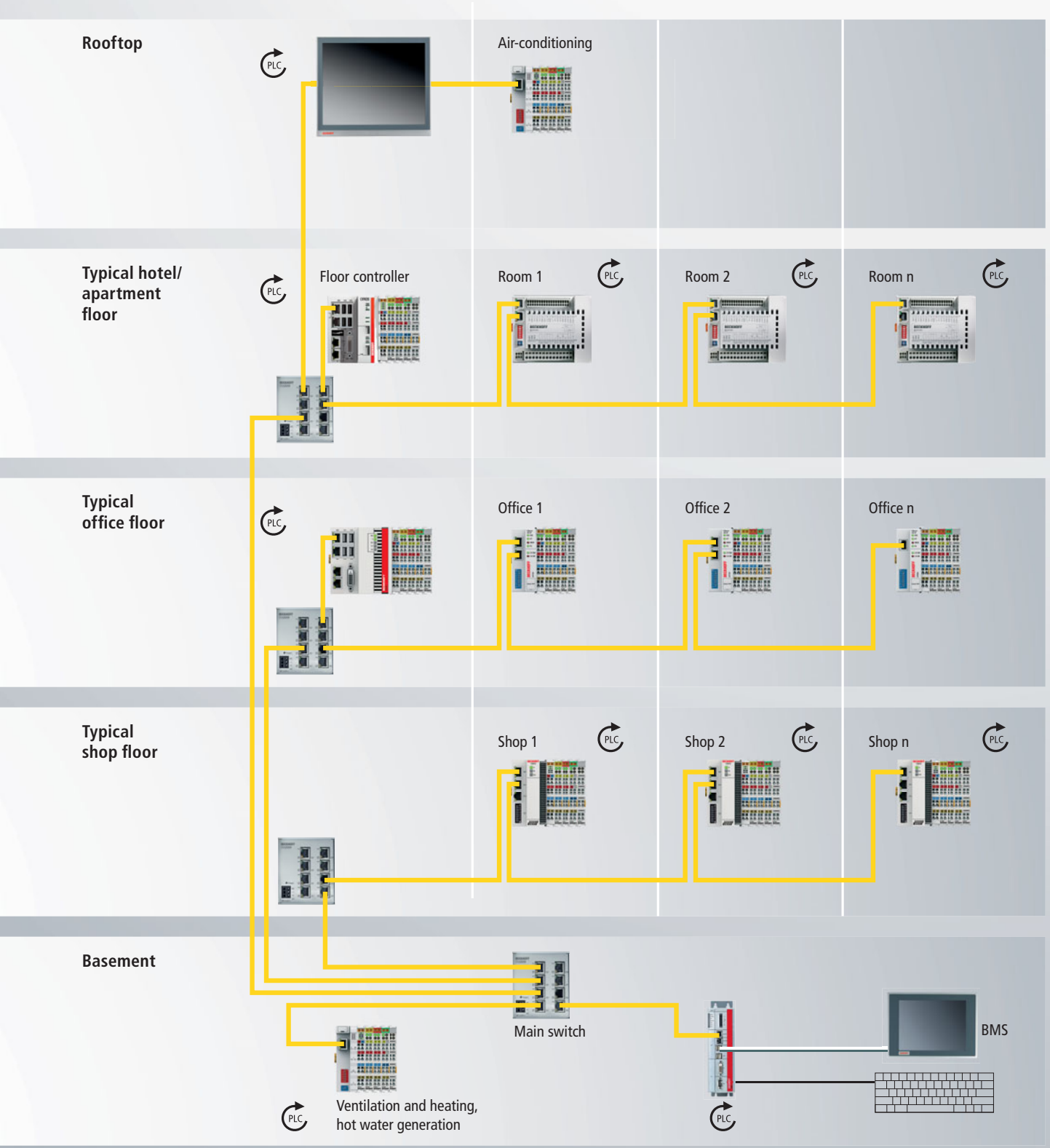

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Integration of external systems

On the sensor/actuator and automation level, different fieldbuses such as SMI, DALI, DMX, EnOcean, M-Bus, MP-Bus, LON, and EIB/KNX can be used. Depending on requirements, these can be freely combined, i.e. no expensive gateway solutions are required because the protocols can be connected directly via the Bus Terminal system.

The following software solutions are suitable for connection of third-party systems and can be used as a single solution throughout:

FIAS
The Fidelio FIAS protocol (Fidelio Interface and Application Specification) is becoming the world's leading hotel management software. Since there is a constantly growing demand for networked systems and room automation in hotels, the TwinCAT FIAS Server provides a direct FIAS interface that facilitates smooth communication between hotel management systems and PLCs.

Crestron
Crestron Electronics is a market-leader in media management systems. In addition to the management of audio and video systems, building services components can also be integrated. The data between the Crestron management system and Beckhoff hardware is exchanged via Ethernet. For the Crestron control systems, software modules (user modules) are available. The Crestron controller can access read and write commands; the Beckhoff controller can, with the aid of the TwinCAT Crestron Server, write data to the Crestron control system or extract data from it.

B & O
Bang & Olufsen is world-famous for its unique range of high-quality audio, video and multi-media products. The TwinCAT Bang & Olufsen Server is a software package for access to the B & O Masterlink Gateway. It enables communication between a TwinCAT PLC and the Bang & Olufsen multimedia network via TCP/IP.

Integration of further systems
In collaboration with innovative suppliers, more and more systems and devices can be integrated into the Beckhoff control platform, for example, to implement operating, fire protection and access control systems, or sensors.

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Integrated building automation in detail

For the implementation of building automation solutions, Beckhoff offers a comprehensive range of hardware and software modules that can be used both in individual building systems and across different systems. The following pages contain examples to illustrate the use of individual components in different building systems.

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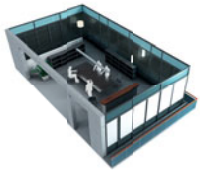
We reserve the right to make technical changes.

Room automation hotels
Page 48

Central HVAC system
Page 56



Room automation offices
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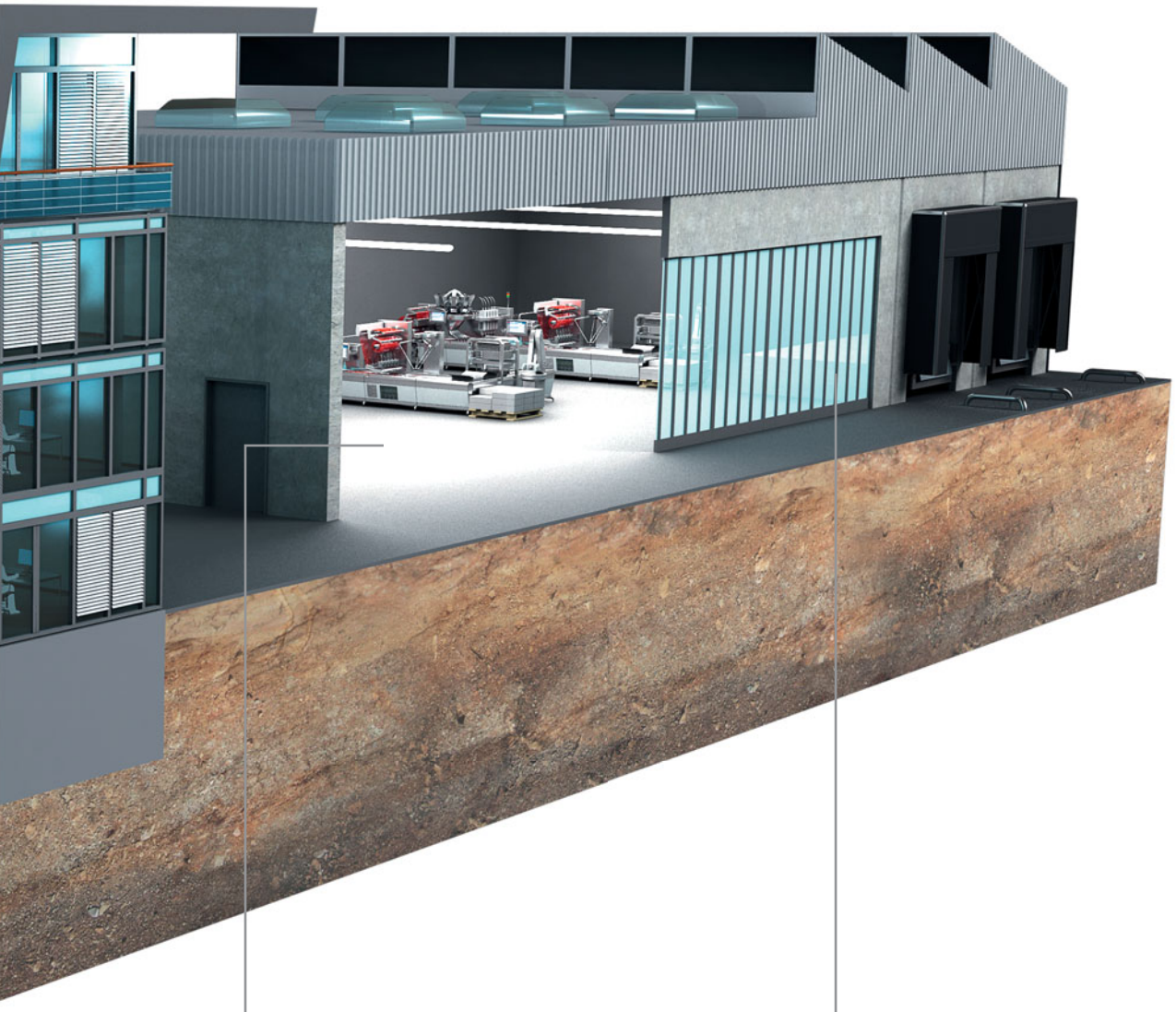

Automation of industrial buildings
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Automation of machines and plants
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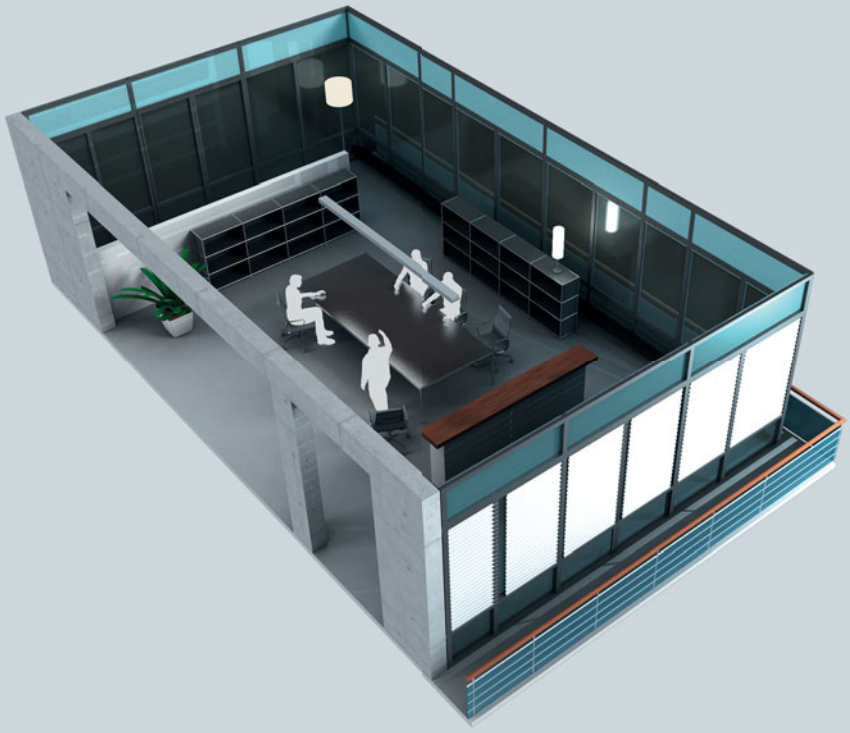
Room automation, offices

Having building systems that work together intelligently saves money not only during the construction of an office building, but also over the long term through increased energy efficiency. Heating, ventilation and air conditioning systems run only when needed. Lighting is controlled based on demand, daylight, occupancy, and even season. Blinds and shades are controlled based on wind speed and the position of the sun. Media systems in conference, training and seminar rooms are integrated into the existing building automation platform.

Beckhoff solutions

Communication between the individual automation stations takes place via Ethernet TCP/IP. The level of automation in a room can be individually adjusted through free configuration of individual Bus Terminals. Alternatively, the BC9191 room controller integrates these functions within a single module. Rooms and/or areas with repeat requirements need only be programmed once and can be replicated. With features like these, an efficient, multi-component room automation system can be implemented that meets energy efficiency class A.



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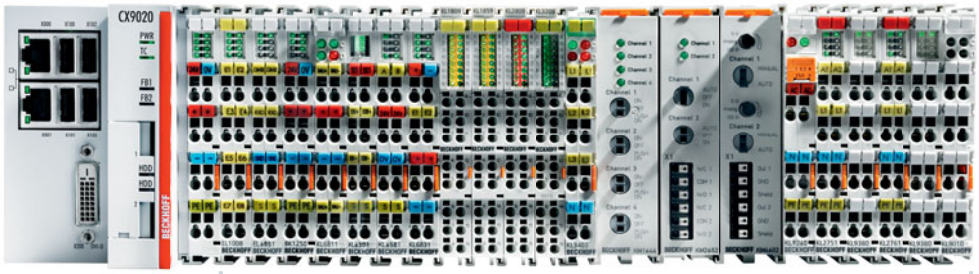
Software modules: TwinCAT Building Automation

The extension of the TwinCAT PLC HVAC Libraries contains comprehensive room automation functions. By coupling a daylight-dependent control unit with glare protection as well as heating and cooling functions, significant synergies can be generated. Using object orientation, various functions can be represented as PLC function blocks:

- Occupancy sensor
- Time program
- Automatic lighting
- Daylight sensor
- Constant light control
- Slat adjustment
- Shading correction
- Automatic temperature control
- Energy level selection with start optimisation
- Target point determination
- Function selection
- Temperature control (heating/cooling)
- Sequence control
- Target value limiter
- Air quality control
- Night cooling

Hardware modules: Bus Terminals



Bus Coupler/
Embedded PC

Field level

HVAC

- Mechanical ventilation
- Ventilation
- Air quality
- Heating
- Cooling
- Temperature
- Humidity control

Lighting

- Automatic dimmer system
- Occupancy sensor
- Constant light regulation
- DALI
- Light switch
- Switchable power outlets

Façade/door

- Thermo-automatic control
- Shading
- Access

Operation and monitoring

- Control panel
- Mobile controller

We reserve the right to make technical changes.

Sample configuration

Traditional floor and room | standard room automation

Product	Description
CX5010-1111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *
- CX1900-0025	2 GB CF card instead of 64 MB *

* optional BACnet components

KL1809	16-channel digital input 24 V DC
	Dew point monitor
	Window contact
	Occupancy sensor
	Light switch for floor lamps
	Light switch for ceiling lights
	Shutter switch UP
	Shutter switch DOWN
KL2809	16-channel digital output 24 V DC
	Actuator for heating
	Actuator for cooling
KL3208-0010	PT1000 8-channel analog input
	Room temperature sensor
	Temperature setpoint
KL3468	8-channel analog input 0…10 V
	Air quality sensor
	Light sensor
KL9186	Potential distribution terminal 24 V DV
KL9187	Potential distribution terminal 0 V DV
KL4408	8-channel analog output 0…10 V
	Volume flow controller
KL2641	1-channel relay output terminal 230 V AC, 16 A
	Switchable floor lamp power outlet
KL9160	Potential feed terminal with diagnostics, 230 V AC
KL2602	2-channel relay output terminal 230V AC
	Light switch
KL9160	Potential feed terminal 120…230 V AC, with diagnostics
KL2722	2-channel triac output terminal 230 V AC
	Sunshade actuator UP
	Sunshade actuator DOWN
KL9010	End terminal

Floor and room with fieldbus | Room automation with DALI, SMI, and Enocean

Product	Description
CX5010-1111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *
- CX1900-0025	2 GB CF card instead of 64 MB *

* optional BACnet components

KL1104	4-channel digital input terminals 24 V DC
	Dew point monitor
KL2809	16-channel digital output 24 V DC
	Actuator for heating
	Actuator for cooling
KL6581	EnOcean master terminal
KL6583	EnOcean transmitter and receiver
	Air quality sensor
	Temperature setpoint
	Light switch for floor lamps
	Light switch for ceiling lights
	Shutter switch UP
	Shutter switch DOWN
	Window contact
	Room temperature sensor
KL6811	DALI/DSI master and power terminal, 64 units max.
	Light sensor
	Occupancy sensor
	Light control
KL6771	MP bus master terminal, 8 drives max.
	Volume flow control
KL2641	1-channel relay output terminal 230 V AC, 16 A
	Switchable floor lamp power outlet
KL6841	SMI master terminal 230 V AC, 16 drives max.
	Sunshade actuator UP
	Sunshade actuator DOWN
KL9010	End terminal

The BK9000, BK9050 or BK9100 Bus Coupler makes it easy to expand the decentralized room automation system. You simply replace the CX controller with one of these Bus Couplers. The terminals are the same.

We reserve the right to make technical changes.

Room automation, hotels

To keep costs under control, hotels must pay especially close attention to their energy efficiency. Without affecting their guests' well-being, they can save energy by intelligently controlling the heating and cooling of hotel rooms. Various illumination scenarios in the lounge, restaurant and spa areas can set the mood based on usage and time of day. For cost-sensitive hotel room applications, the compact BC9191 Room Controller delivers all the features for a standard room in a compact housing.

Beckhoff solutions

Decentralised room automation with CX9020 and BC9191
This setup offers maximum modularity because every zone has a decentralized control system for which the parameters can be freely defined. An embedded controller communicates with the building management system in the respective zone in order to transfer all the data. For a more upscale setup, each room or suite can be equipped with a CX9020 Embedded PC for maximum flexibility.

Central control functions
A central floor or building controller is recommended for general functions such as floor or staircase lighting, the FIAS server link, and higher-level functions based on weather data, for example.

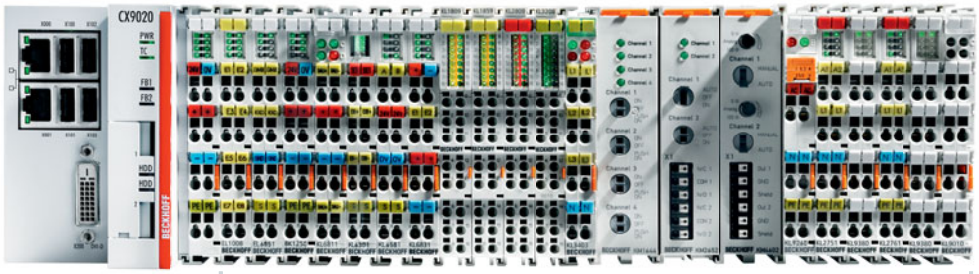
We reserve the right to make technical changes.

Software modules: TwinCAT Building Automation

A hotel reservation system can be integrated via the TwinCAT FIAS Server. Media devices and systems for meeting or seminar rooms can also be easily integrated into the room automation system.

- Automatic occupancy registration
- Timer program
- Automatic lighting
- Daylight sensor
- Automatic temperature control
- Energy level selection with start optimisation
- Setpoint determination
- Function selection
- Temperature control (heating/cooling)
- Sequence control

Hardware modules: Bus Terminals



Bus Coupler/
Embedded PC

Field level

HVAC

- Cooling
- Humidity
- Ventilation
- Temperature
- Heating

Lighting

- Constant light control
- Motion detector
- Switchable power outlets

Façade/door

- Shading
- Access

Operation and monitoring

- Mobile controller
- FIAS Server
- Control panel

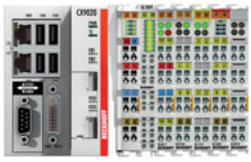
We reserve the right to make technical changes.

Sample configuration

Floor controller

Product	Description
CX9020-0111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *
- TS8035	TwinCAT FIAS Server

* optional BACnet and FIAS components



KL1809	16-channel digital input 24 V DC
	Window contact
	Light switch for secondary rooms
KL6811	DALI/DSI master and power terminal, 64 units max.
	Light controller
KL9160	Potential feed terminal 120…230 V AC, with diagnostics

KL1722	2-channel digital input terminal 120/230 V AC
	Occupancy sensor
KL2602	2-channel relay output terminal 230V AC
	Light switch for secondary rooms
KL9010	End terminal

Standard hotel room

Digital inputs
Dew point monitor
Window contact
Occupancy sensor
Analog inputs
Room temperature sensor
Temperature setpoint

Digital outputs
3-stage fan coil
Air heater
Analog outputs
Actuator for heating
Actuator for cooling
Serial communication

Deluxe hotel room

Product	Description
CX9020-0111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *

* optional BACnet and FIAS components

EL6581	DMX master
	Lighting
BK1250	Coupler between E-bus and K-bus terminals
KL9400	Power supply terminal to refresh K-bus
KL1809	16-channel digital input 24 V DC
	Dew point monitor
	Window contact
	Occupancy sensor
	Light switch for floor lamps
	Light switch for ceiling lamps
	Curtain switch OPEN
	Curtain switch CLOSED
	Shutter switch UP
	Shutter switch DOWN
KL2284	4-channel digital output terminal 24 V DC, 2 A, reversible
	Curtains CLOSED
	Curtains OPEN

KL3208-0010	PT1000 8-channel analog input
	Room temperature sensor
	Temperature setpoint
KL4408	8-channel analog output 0…10 V
	Volume flow controller
	Heating valve
	Cooling valve
KL2641	1-channel relay output terminal 230 V AC, 16 A
	Switchable floor lamp power outlet
KL9160	Potential feed terminal 120…230 V AC, with diagnostics
KL2751	1-channel universal dimmer terminal 230 V AC
	Lighting
KL9160	Potential feed terminal 120…230 V AC, with diagnostics
KL2722	2-channel triac output terminal 230 V AC
	Shutters UP
	Shutters DOWN
KL9010	End terminal

We reserve the right to make technical changes.

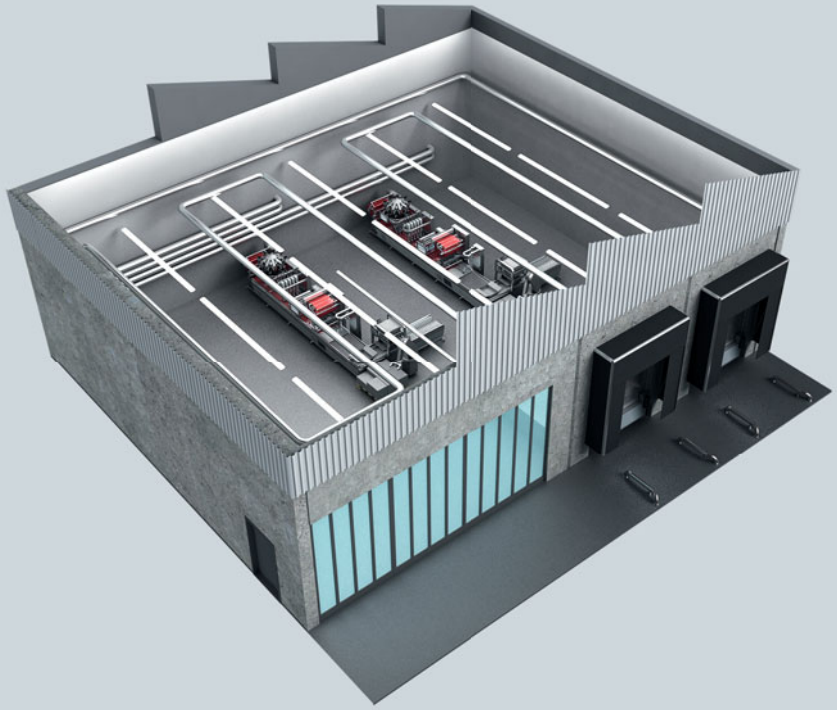
We reserve the right to make technical changes.

Industrial buildings

More and more industrial buildings employ intelligent building automation systems, because seamless interaction of all components reduces costs both during construction and operation. The building automation system measures, controls, regulates and optimises the complex operations of the different systems depending on the building's utilisation, thus ensuring that everything works efficiently. For example, the BA system controls the lighting in storage areas, production areas and on roadways based on need, time of day, season, and the presence of people. Heating, ventilation and air conditioning systems run only when needed as well. Using smart-grid functions, the systems can even be switched on or off depending on the power grid load.

Beckhoff solutions

The extensive Beckhoff Bus Terminal portfolio features I/O modules for a wide spectrum of applications and functions. Mechanical ventilation systems with automated roof vents can be controlled via the Beckhoff KL2722 Bus Terminal. The KM3702 monitors product media such as compressed air. For reading and analysing the consumption of heat, water and gas as well as power meters, the KL6781 M-Bus master terminal is available. The KL3403 power monitoring terminal is used for the direct metering of electricity. Even highly sensitive clean-room applications can be controlled with high precision measurement technology from Beckhoff.



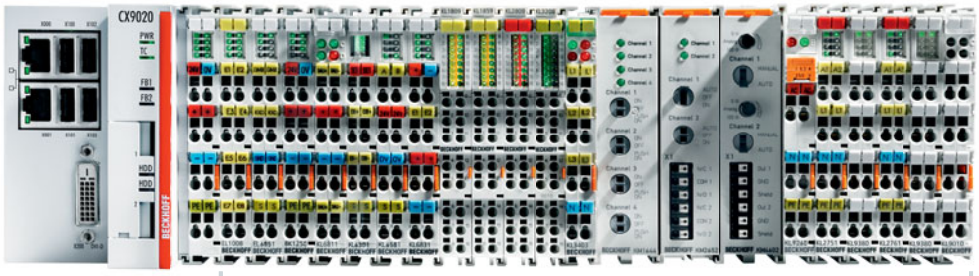
We reserve the right to make technical changes.

Software modules: TwinCAT Building Automation

The TwinCAT BA Libraries coordinate the operation of measurement, open-loop and closed-loop controllers for an optimised, energy-efficient interaction.

- Occupancy sensor
- Timer program
- Automatic lighting
- Daylight sensor
- Constant light regulation
- Slat control
- Shading correction
- Automatic temperature control
- Energy level selection
- Energy level selection with start optimisation
- Setpoint determination
- Function selection
- Temperature control (heating/cooling)
- Cascade control for air supply temperature
- Fan control
- Sequence control
- Setpoint limiter
- Air quality control
- Night cooling
- Load optimisation

Hardware modules: Bus Terminals



Bus Coupler/
Embedded PC

Field level

HVAC

- Temperature
- Cooling
- Ventilation
- Air quality control
- Heating
- Humidity

Lighting

- Constant light regulation
- DALI
- Occupancy sensor
- Daylight sensor

Façade/door

- Rolling shutter gate
- Mechanical ventilation via roof vents
- Access

Operation and monitoring

- Remote maintenance
- Control panel
- Energy data measurement
- Pressurised air monitoring
- Timer

We reserve the right to make technical changes.

Sample configuration

Standard automation of industrial buildings

Product	Description
CX9020-0111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *

* optional BACnet components

KL1809	16-channel digital input 24 V DC
	Door contact
	Window contact
	Light switch
	Precipitation sensor
	Rolling shutter gate UP
	Rolling shutter gate DOWN
	Roof vent OPEN
	Roof vent CLOSED
KL6581	EnOcean terminal
KL6583	EnOcean transmitter and receiver
	Light switch
	Roof vent OPEN
	Roof vent CLOSED
	Room temperature sensor
KL6811	DALI/DSI master and power terminal, 64 units max.
	Constant light control
	Light switch
KL6781	M-Bus master terminal
	M-Bus gas meter
	M-Bus power meter
	M-Bus water meter
KM3702	2-channel absolute pressure measuring terminal 7,500 hPa (7.5 bar)
	Pressurised air monitor
KL2809	16-channel digital output 24 V DC
	Actuator for heating
	Actuator for cooling
	Ventilation level 1
	Ventilation level 2
	Ventilation level 3

KL3208-0010	PT1000 8-channel analog input
	Room temperature sensor
	Temperature setpoint
KL3468	8-channel analog input 0…10 V
	Air quality sensor
	Light sensor
KL9186	Potential distribution terminal 24 V DV
KL9187	Potential distribution terminal 0 V DV
KL3454	4-channel analog output terminal 4…20 mA
	Wind sensor
	Daylight sensor
	Outside temperature
KL9400	Power supply terminal to refresh K-bus, 24 V DC, 2A
KL3403	3-phase power monitoring terminal
	System power metering
KL9160	Potential feed terminal with diagnostics, 230 V AC
KL1722	2-channel digital input terminal 120/230 V AC
	Occupancy sensor
KL2722	2-channel triac output terminal 230 V AC
	Roof vent OPEN
	Roof vent CLOSED
KL2622	2-channel relay output terminal 230 V AC, 2 A, potential-free relay contacts
	Rolling shutter gate UP
	Rolling shutter gate DOWN
KL2622	2-channel relay output terminal 230 V AC, 2 A, potential-free relay contacts
	Ventilation ON
KL9010	End terminal

We reserve the right to make technical changes.

We reserve the right to make technical changes.

Central HVAC systems

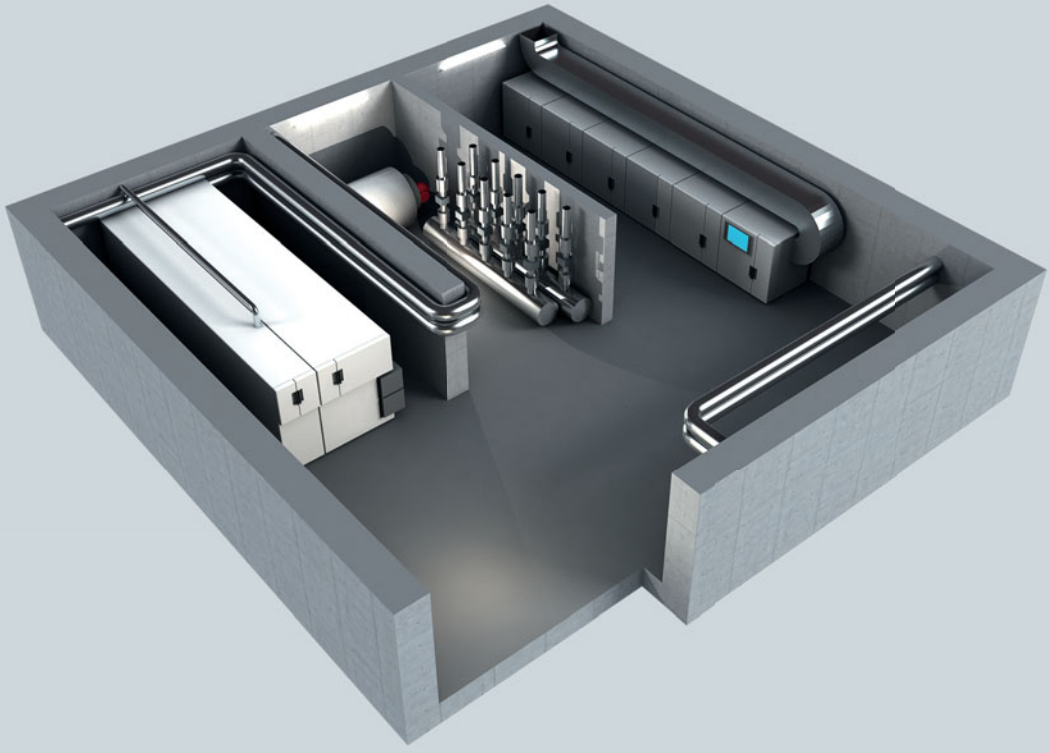
The control of heating, ventilation and air conditioning systems is very important in building automation, both concerning the well-being of the user and the reduction of energy consumption. Alongside the standard hardware portfolio for integration of all data points, Beckhoff provides a software tool that covers the entire scope of functions of an intelligent HVAC control system. The TwinCAT PLC HVAC software library offers programmers and users the following benefits: efficient parameterisation and commissioning, a consistently high level of system functionality, good readability and expandability of programs, ease of maintenance over many years, flexible expandability of systems, improved reusability of templates for systems or system modules, easy training of service personnel, definition of a clear, object-oriented program structure, and good documentability of programs.

The system is rounded off by manual operating modules for integration into control cabinet doors; these allow monitoring and operation of the system without having to open electrical cabinets. Process data is represented directly using the K-bus in the PLC. The coloured configurable LEDs give a clear view of the system status.

Energy data collection

Running a system efficiently requires a lot of measurement technology. Besides its standard portfolio of hardware and software, Beckhoff offers as part of its TwinCAT Building Automation Library function blocks that simplify using the KL3403 Power Measurement Terminal considerably.

These function blocks provide effective and peak values for current, voltage and power. In addition, the free M-Bus library offers many options for reading data from M-Bus slaves with the KL6781 and processing it directly in the PLC. In combination with the multi-meter terminal, TwinCAT Scope 2 provides an easy-to-use tool for collecting data and analysing signals graphically.



We reserve the right to make technical changes.

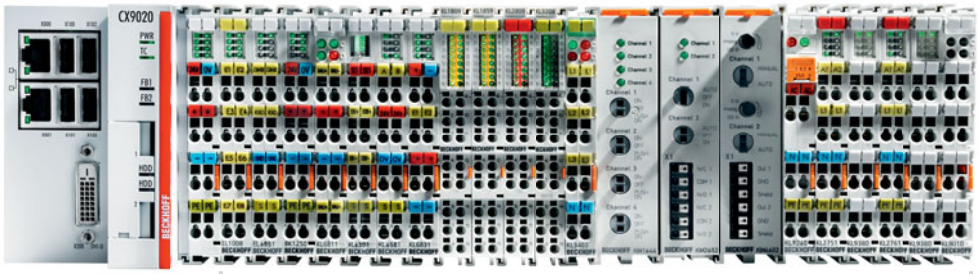
Software modules: TwinCAT Building Automation

TwinCAT PLC HVAC Libraries provides users with software modules to represent actuators, analog modules, controllers, set point modules, clocks, and other functions. As complete software modules they allow, for example, the straightforward scaling of an analog value or the implementation of energy saving functions such as:

- Summer night cooling
- Summer compensation
- Sequence control
- Time schedulers
- Enthalpy calculation
- Pressure control
- Motor control
- Hot water production

For comprehensive use of Bus Terminals for M-Bus, MP-Bus, LON, EIB/KNX and Modbus, other PLC libraries are available.

Hardware modules: Bus Terminals



Bus Coupler/
Embedded PC

Field level

HVAC

- Vent flap
- Ambient temperature
- Ventilation
- Pump
- Cooling/ dehumidifying
- Heating circuit
- Leak measurement
- Pressure measurement
- Humidity
- Temperature
- Air quality
- Energy data acquisition
- Water level
- Sequence controller

Operating and monitoring

- Control panel
- Manual operating module
- Remote maintenance
- Timer

We reserve the right to make technical changes.

Sample configuration

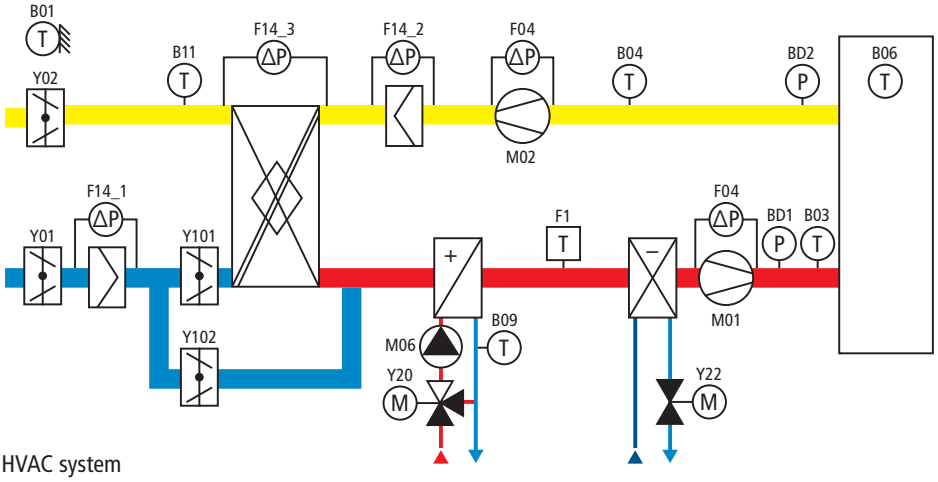
HVAC system

Product	Description
CX5010-1111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *
- CX1900-0025	2 GB CF-Card instead of 64 MB *

* optional BACnet components

KL1809	16-channel digital input 24 V DC
M01_2	Supply air frequency converter fault signal
M01_3	Supply air frequency converter operating signal
M01_5	Supply air repair switch
M02_2	Exhaust air frequency converter fault signal
M02_3	Exhaust air frequency converter operating signal
M02_5	Exhaust air repair switch
M06_2	Preheating pump operating signal
M06_3	Preheating pump fault signal
Y01_2	Ambient air gate stop position OPEN
Y02_2	Exhaust air gate stop position OPEN
Y102_2	Heat recovery bypass gates stop position OPEN
F1	Antifrost thermostat
KL3208-0010	PT1000 8-channel analog input
B01	Ambient air temperature
B03	Supply air temperature
B04	Exhaust air temperature
B06	Room temperature
B09	Preheater return temperature
B000	Exhaust air temperature
KL9186	Potential distribution terminal 24 V DV
KL9187	Potential distribution terminal 0 V DV

KL3468	8-channel analog input 0…10 V
F03	Supply air differential pressure sensor
F04	Exhaust air differential pressure sensor
F14_1	Ambient air filter differential pressure sensor
F14_2	Exhaust air filter differential pressure sensor
F14_3	Heat recovery differential pressure sensor
BD1	Supply air pressure
BD2	Exhaust air pressure
KM2652	2-channel relay module 230 V AC, 6 A, manual/automatic operation
M01_1	Supply air frequency converter clearance
M02_1	Exhaust air frequency converter clearance
M06_1	Preheating pump clearance
Y01_1	Ambient air gate
Y02_1	Exhaust air gate
KM4602	2-channel analog output 0…10 V, manual/automatic operation
M01_4	Supply air VFD target setting
M02_4	Exhaust air VFD target setting
Y102_1	Heat recovery bypass gates
Y20	Preheater control valve
Y22	Cooling control valve
KL9010	End terminal

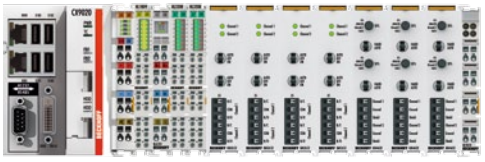


We reserve the right to make technical changes.

Central heating system

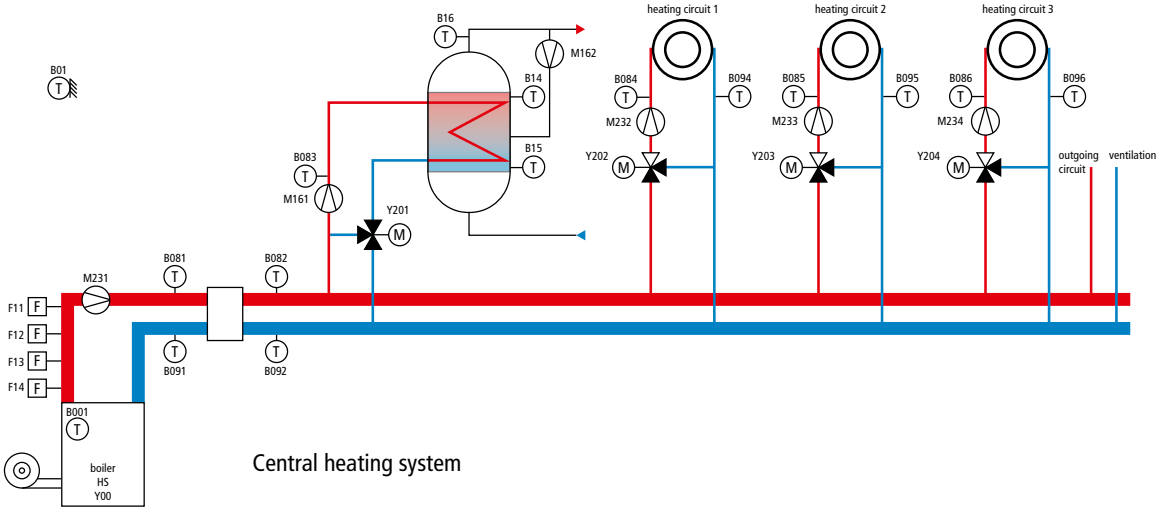
Product	Description
CX9020-0111	TwinCAT PLC, Windows CE
- CX1800-1052	Windows CE, BACnet image *

* optional BACnet component



KL1809	16-channel digital input 24 V DC
F12	Maximum boiler pressure
F13	Minimum boiler pressure
F14	Boiler temperature safety limiter
M231_2	Primary pump fault
M231_3	Primary pump operation
M232_2	Heating circuit 1 pump fault
M232_3	Heating circuit 1 pump operation
M233_2	Heating circuit 2 pump fault
M233_3	Heating circuit 2 pump operation
M234_2	Heating circuit 3 pump fault
M234_3	Heating circuit 3 pump operation
M161_2	Storage charge pump fault
M161_3	Storage charge pump operation
M162_2	Circulation pump fault
M162_3	Circulation pump operation
KL6781	M-Bus master terminal
Z1	Heat meter
Z2	Service water meter
Z3	Gas meter
Z4	Power meter
KL3208-0010	PT1000 8-channel analog input
B001	Boiler temperature
B081	Primary hydraulic gate flow temperature
B091	Primary hydraulic gate return temperature
B082	Secondary hydraulic gate flow temperature
B092	Secondary hydraulic gate return temperature
B083	Hot water flow temperature
B094	Heating circuit 1 return temperature
B084	Heating circuit 1 flow temperature

KL3208-0010	PT1000 8-channel analog input
B095	Heating circuit 2 return temperature
B085	Heating circuit 2 flow temperature
B096	Heating circuit 3 return temperature
B086	Heating circuit 3 flow temperature
B14	Hot water boiler, top
B15	Hot water boiler, bottom
B16	Hot water service water temperature
B01	Ambient temperature
KM2652	2-channel relay module 230 V AC, 6 A, manual/automatic operation
Y00	Boiler clearance
HBU2	Boiler operation
M231_1	Primary pump clearance
M232_1	Heating circuit 1 pump clearance
M233_1	Heating circuit 2 pump clearance
M234_1	Heating circuit 3 pump clearance
M161_1	Storage charge pump
M162_1	Circulation pump
KM4602	2-channel analog output 0…10 V, manual/automatic operation
Y00	Boiler modulation
Y201	WWB control valve
Y202	Heating circuit 1 control valve
Y203	Heating circuit 2 control valve
Y204	Heating circuit 3 control valve
KL9010	End terminal



Central heating system

We reserve the right to make technical changes.

Remote maintenance

Due to complexity, the automation of buildings and real estate requires access using remote diagnostics, remote maintenance and remote control. To avoid unnecessary costs caused by system failures, rapid support by specialists is required for error diagnosis, software maintenance, and for the import of updates. For ongoing building operation and for system optimisation, information on process variables is required together with warning and error messages made available to service personnel by e-mail, for example.

Beckhoff solutions

Diagnostics and services

- networking via cable (e.g. ISDN, DSL) or using mobile radio (e.g. GSM, EDGE, UMTS)
- availability of known Internet technologies such as FTP, HTML, SOAP, WCF, REST, WebService, through the use of PC-based automation technology
- use of Cloud services from PLC such as data logging
- support of communication protocols BACnet/IP, OPC/UA, IEC 61850 (extension of IEC 61850-7-420), IEC 60870-5-102, IEC 60870-5-103 and IEC 60870-5-104
- use of TwinCAT Scope 2 for logging of trend data on the Scope server

We reserve the right to make technical changes.

Software modules: TwinCAT Building Automation

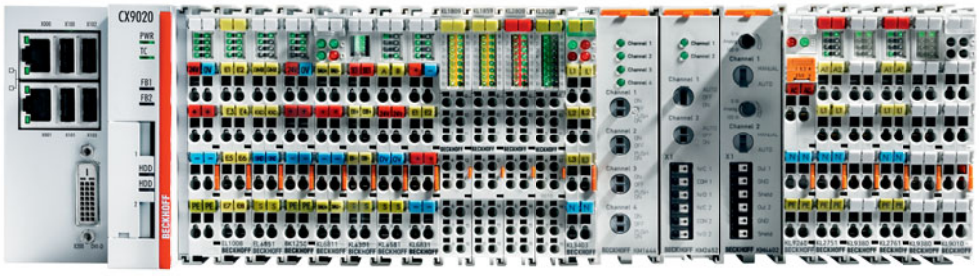
Remote control

- Sending of text messages and e-mails directly from the control unit for notification of service personnel
- Remote Desktop, Lync or Team Viewer enable operation of the entire PC controller via Internet/Intranet, including across long distances
- Operation and monitoring using HTML pages stored directly on the control unit
- Database link
- Diagnostics
- E-mail dispatch
- SMS dispatch
- Data logging
- Online change
- Remote user access

Remote programming

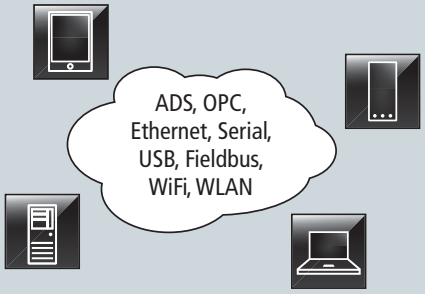
- Full access to the control unit for modification of system configurations and control program by means of "online change"
- Central administration of Beckhoff CE controllers via the TwinCAT management server
- VPN router for secure access via Internet/ Intranet or mobile radio

Hardware modules: Bus Terminal



Bus Coupler/
Embedded PC

Operation and monitoring



We reserve the right to make technical changes.

BECKHOFF
CX8090
TC
STATUS
HDD
X001
X101
X102
S101
1 2 3 4 5 6 7 8 9 10
Ethernet

Product data for technicians

Beckhoff offers modular automation components of finely grained I/Os, scalable controllers and modular software that enables implementation of all building automation requirements, with particular focus on energy efficiency and sustainability. In combination, they enable application-specific solutions for all building types and utilisation options.

Section 1 02 Industrial Building Automation

Section 2 26 Planning I Building systems I Solutions

Section 3 Product data

64 Modular automation components from Beckhoff
66 Open control architecture
68 Scalable control technology – The right controller for every application
70 TwinCAT – The universal automation software platform for building automation
74 Bus Terminals – The complete I/O system
78 Information media

Modular automation components from Beckhoff

For building automation applications Beckhoff offers a system consisting of software, controllers and Bus Terminals. The flexible application options of the three system components facilitate integration of the requirements for automation solutions. This section describes the core building automation components.

Scalable control technology

The right controller for each application
The scalable, modular control system from Beckhoff offers the right solution for any task, from the high-performance Industrial PC or Embedded PC as main building computer up to local Ethernet controllers.

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Bus Terminals – The complete I/O system

The I/O components
The Beckhoff Bus Terminal system for connection of data points features 400 different I/O terminals and supports all common sensors and actuators.

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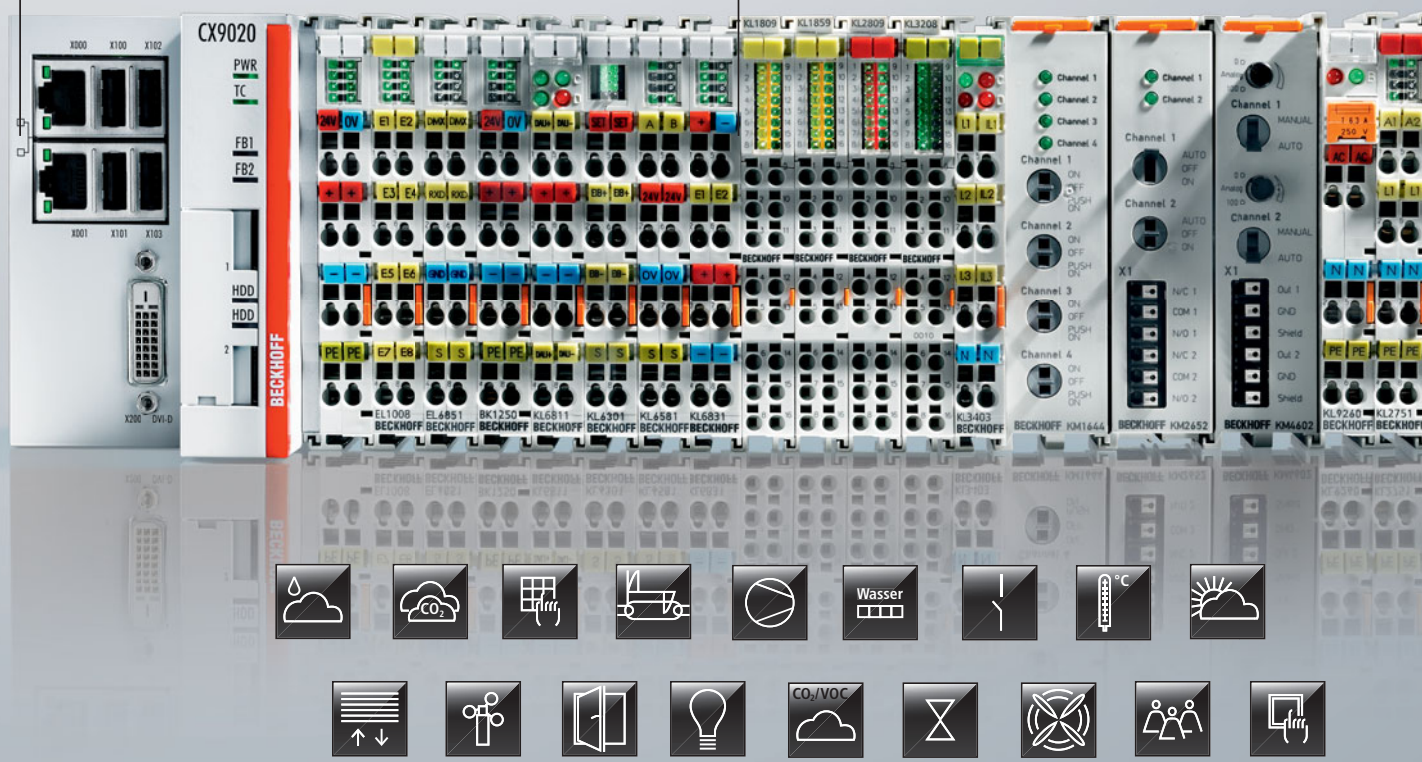
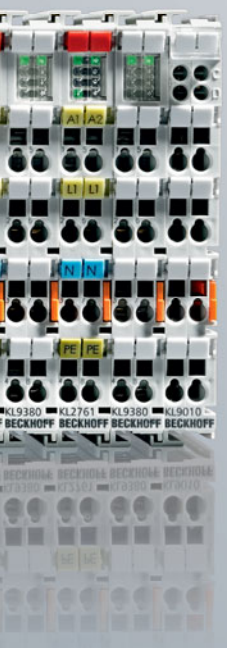


We reserve the right to make technical changes.

TwinCAT – The universal software platform

Maximum flexibility
PC-based control technology enables all building functions and function changes to be realised in software based on TwinCAT, which consists of a wide range of software modules and offers users maximum flexibility. The use of standard software components, which integrate all key building functions, reduces the engineering costs significantly.

Page 70



We reserve the right to make technical changes.

Open control architecture

Management level

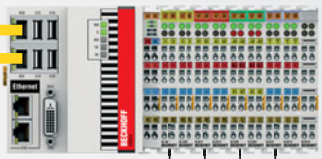
Master computer

FMS

ERP

BACnet/IP, real-time Ethernet, ADS, OPC-UA, Modbus TCP, PROFINET

Automation level



Embedded PC, Bus Terminals

Field level

Room Controller

We reserve the right to make technical changes.

DMX
Modbus RTU
MP-Bus

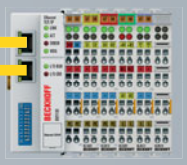
Embedded PC, Bus Terminals

Digital I/O
Analog I/O
PROFIBUS
PROFINET
CANopen
DMX

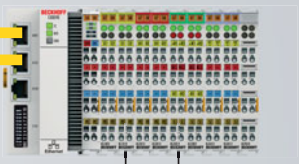
Digital I/O
Analog I/O

Embedded PC, Bus Terminals

Panel PC

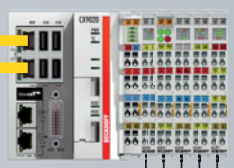


Bus Coupler,
Bus Terminals



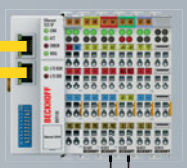
Digital I/O
Analog I/O

Embedded PC, Bus Terminals



EnOcean
DALI
M-Bus
LON
EIB/KNX

Embedded PC, Bus Terminals



Digital I/O
Analog I/O

Bus Coupler, Bus Terminals

We reserve the right to make technical changes.

Scalable control technology – The right controller for every appl

Room automation
Small application

Room zone automation
Zone control

System level automation
System

Panel PC CP6606-0001

Control cabinet PC C6925

Embedded PC CX5010

Embedded PC CX8090, CX8091

Embedded PC CX9020

Room Controller BC9191

Bus Terminal Controller BC9100

Room Controller BC9191

PLC

We reserve the right to make technical changes.

ication

Floor level automation

Multi-touch Panel PC
CP2215

Building management system and system automation

Multi-touch Panel PC
CP2218

Building management system

Control cabinet PC C5210

Control cabinet PC C6930

Industrial PCs
Panel PCs

Embedded PC CX5020

Embedded PC CX5140

x86-based
Embedded PCs

Embedded PC CX9020

ARM-based
Embedded
PCs

Scalable controller performance: from 16-bit CPU to x86 CPU with 2.7 GHz on 4 cores

We reserve the right to make technical changes.

TwinCAT – software-based control technology for building automation

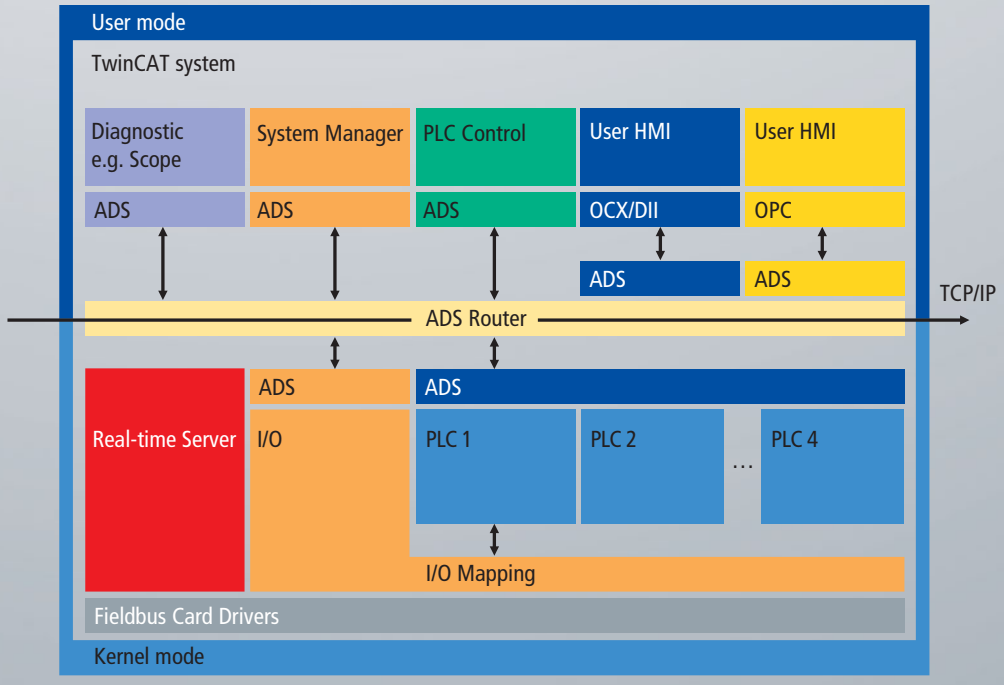
When Beckhoff introduced its PC-based control technology in 1986, the company also created a worldwide standard for automation. On the software side, the TwinCAT automation suite is at the heart of the controller. (TwinCAT stands for "the Windows control and automation technology".) TwinCAT converts nearly any PC-based system into a real-time controller with multiple PLC runtime systems. All building automation systems are programmed and parameterised with TwinCAT. The engineering environment has been designed for all popular programming standards in the IT and automation fields from IEC 61131 to C/C++. Predefined software modules simplify the engineering process, and functional enhancements or modifications are possible at any time.

High-end PLC

- internationally-recognised IEC 61131-3 programming standard
- reusable software modules
- almost unlimited memory
- unlimited number of function blocks and variables
- high-speed software solutions for controllers, etc.
- up to four runtime systems per PC, up to four tasks per runtime system

Communication interface TwinCAT ADS

- universal vertical and horizontal communication
- cyclical/event-triggered
- Open protocol with documented examples for:
  - C/C++
  - .NET
  - Delphi
  - Java
  - JavaScript
  - WebService
  - WCF
- available on Windows operating systems
- access from the PLC via function blocks possible



TwinCAT system architecture

We reserve the right to make technical changes.

TwinCAT Building Automation – efficient engineering for all building systems

To meet the high demands on building automation such as convenience, energy savings, low investment and operating costs, and a rapid return on investment, you must have a thoroughly coordinated control system for all the technical components of a building. With TwinCAT Building Automation, Beckhoff has developed a software product that reduces the engineering effort and integrates all major components of a modern building automation system. Extensive software libraries and supplements extend the concept of the modular range of automation components from Beckhoff to the software level.

The new suite comprises essentially three basic functions:

1. TwinCAT BA PLC Libraries: Basic functions for all systems
2. TwinCAT BA PLC Templates: Templates for all systems
3. TwinCAT BA Project Builder: Configuration tool for linking templates, hardware and BACnet objects

TwinCAT BA PLC Libraries

The TwinCAT BA PLC Libraries provide the system integrator with established and tested building blocks, such as basic functions in the areas of closed-loop control, signal processing, special mathematical functions, fault signal processing and general system functions.

TwinCAT BA PLC Templates

The TwinCAT BA PLC templates are complete TwinCAT program blocks for sensors and actuators, complete modules, as well as partial and whole systems in the areas of HVAC and room automation. Unlike conventional PLC libraries, the TwinCAT BA PLC Templates are imported into the PLC programs as whole modules, which the system integrator can then modify as needed. They can also create their own TwinCAT BA PLC templates.

TwinCAT BA Project Builder

Having a consistent TwinCAT project file structure is a prerequisite for proper plant maintenance. The central underlying idea is the component identification system, which assigns a name to each data point and program module in accordance with defined rules. The TwinCAT BA Project Builder automatically generates for all Beckhoff controllers the project files for TwinCAT PLC Control functions and the TwinCAT System Manager. It can be expanded with custom PLC templates for full engineering flexibility, while special add-ins let you integrate planning resources (for example, Excel lists) as well as visualisation systems. An open add-in interface allows you to integrate planning tools, import Excel lists from TRIC (MSR Software), or connect visualisation systems.

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TwinCAT connectivity – universal communication from the management level to the field level

Having a standards-based communication structure is the key to efficient building automation. Beckhoff provides this kind of control technology as a complete solution with optimally coordinated software and hardware components. With its PC-based control platform that fully utilises the hardware's capabilities, the openness of TwinCAT and the use of standard technologies from building automation and other fields, Beckhoff makes a wide range of non-proprietary solutions possible.

Transparency via ADS, continuous routing via:
- UDP/TCP/serial/Bluetooth/fieldbus/ EtherCAT/SOAP (HTTP)

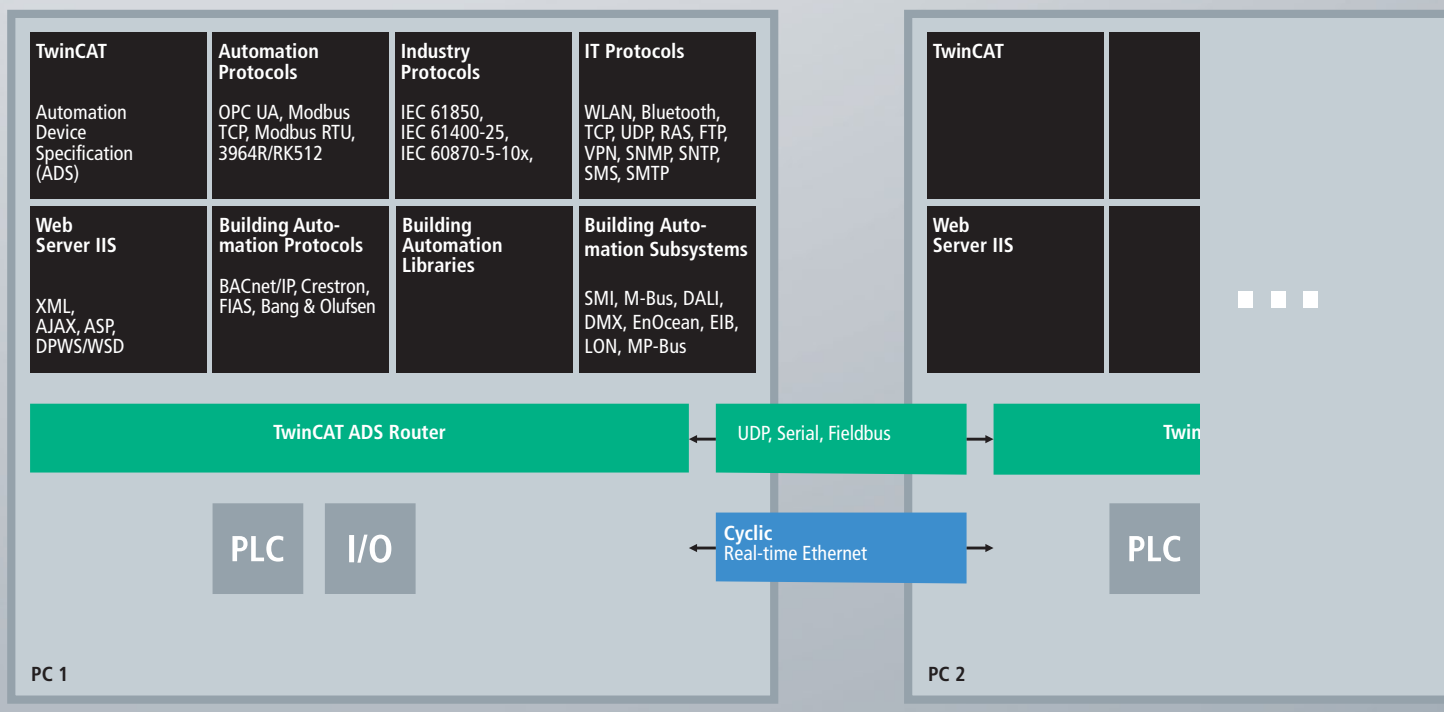
TwinCAT network variables
- publisher/subscriber variables via broadcast, multicast or unicast

Libraries for Building Automation:
- TwinCAT PLC EIB
- TwinCAT PLC LON
- TwinCAT PLC EnOcean
- TwinCAT PLC MP-Bus
- TwinCAT PLC M-Bus
- TwinCAT PLC DALI
- TwinCAT PLC SMI
- TwinCAT PLC DMX

Additional libraries:
- TwinCAT PLC Modbus RTU
- TwinCAT PLC Serial Communication
- TwinCAT PLC IEC 60870-5-10x
- TwinCAT PLC IEC 61850 Server

Supplements for Building Automation:
- TwinCAT BACnet/IP
- TwinCAT OPC UA
- TwinCAT Building Automation
- TwinCAT FIAS Server
- TwinCAT Crestron Server
- TwinCAT Bang & Olufsen Server

Additional Supplements:
- TwinCAT Database Server
- TwinCAT Modbus TCP Server
- TwinCAT ADS Communication Library
- TwinCAT Scope 2
- TwinCAT TCP/IP Connection Server
- TwinCAT XML Data Server
- TwinCAT SMS/SMTP Server
- TwinCAT PLC HMI
- TwinCAT PLC HMI Web



Automation/industrial/IT protocols – TwinCAT supports all common standards.

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Bus Terminals – The complete I/O system

Ethernet

The Beckhoff Bus Terminal system supports all common sensors and actuators with 400 different I/O terminals.

Bus Coupler series BK, the link between Bus Terminals and fieldbus

Bus Terminal Controller series BC with integrated IEC 61131-3 PLC

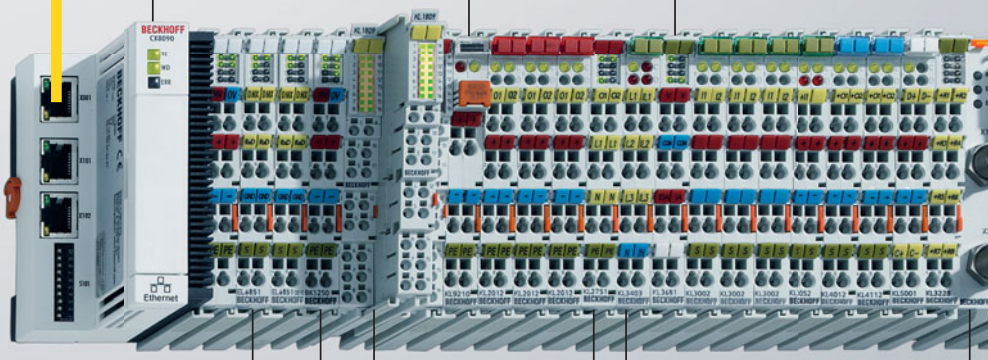
Embedded PC series CX with integrated fieldbus slave

Embedded PC series CX for PLC and Motion Control applications

Head station of the Bus Terminals: Bus Couplers, Bus Terminal Controllers or Embedded PCs

Potential feed terminals for the configuration of different potential groups

Digital multimeter terminal for the direct measurement of current and voltage



DMX master or slave for integration of lighting, movable light elements or mixing consoles via EtherCAT

Universal dimmer terminals with automatic load detection for control of brightness values independent of the fieldbus

3-phase power measurement terminal for the measurement of all relevant electrical data of the supply network

BK1250 "Compact" Coupler between E-bus and K-bus terminals

Bus Terminals in 1-, 2-, 4-, 8- and 16-channel modularity with mixing of any signal type; HD (High-Density) Bus Terminals with 16 connection points in a 12 mm housing for reducing space requirements and costs

Pressure measuring terminals for the measurement of differential and absolute pressures

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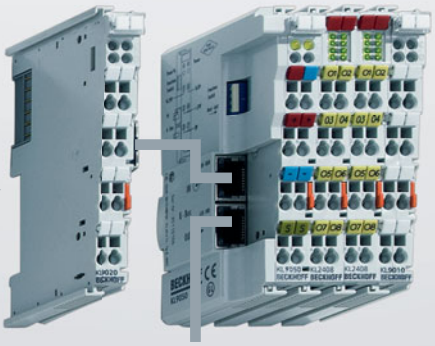
Communication terminals for the integration of subsystems such as EIB/KNX, MP-Bus, LON, DALI, SMI or RS232

More efficient manual/emergency operation using Bus Terminals: switch or potentiometer in Bus Terminal format for process data change independent of the controller

TwinSAFE Bus Terminals for the connection of all common safety sensors and actuators

M-Bus master terminal for direct connection of M-Bus devices

Bus end terminal

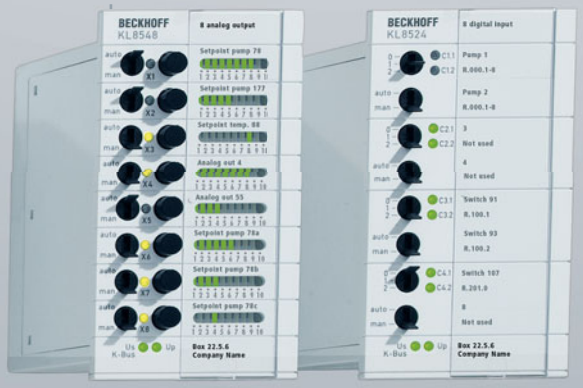


Terminal bus extension for the connection of up to 255 (instead of 64) Bus Terminals to a station

EnOcean master for receiving or sending signals via radio transmission

Bus Terminals with a maximum measuring error of ±0.01% extend the range of applications to high-precision measurement technology.

Manual operating modules enable switching, controlling and monitoring of digital and analog signals as well as setting and reading of data and values in the event of a controller failure. Process data connection via K-bus interface with K-Bus extension (up to 31 modules). Signal connection via KL9309.



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Bus Terminals – The complete I/O system

Digital input

Product	Description
KL1012	2-channel digital input 24 V DC
KL1362	2-channel digital input for break-in alarm
KL1404	4-channel digital input 24 V DC
KL1408	8-channel digital input 24 V DC
KL1501	Up/down counter 24 V DC, 100 kHz
KL1804	HD Bus Terminal, 4-channel digital input 24 V DC, 3-wire connection
KL1808	HD Bus Terminal, 8-channel digital input 24 V DC, 2-wire connection
KL1809	HD Bus Terminal, 16-channel digital input 24 V DC
KL1859	HD Bus Terminal, 8-channel digital input + 8-channel digital-output 24 V DC
KL1862	16-channel digital input 24 V DC, type 3, flat-ribbon cable connection
KM1644	4-channel manual operation

Digital output

Product	Description
KL2012	2-channel digital output 24 V DC
KL2284	4-channel digital output 24 V DC, 2 A, reverse switching
KL2404	4-channel digital output 24 V DC
KL2408	8-channel digital output 24 V DC
KL2512	2-channel pulse width output 24 V DC, 1.5 A
KL2602	2-channel relay output
KL2622	2-channel relay output
KL2641	1-channel relay output 230 V AC, 16 A, bistable, manual operation
KL2701	1-channel solid state load relay up to 230 V AC/DC, 3 A
KL2722	2-channel triac output 12…230 V AC
KL2732	2-channel triac output 12…230 V AC
KL2751	1-channel dimmer terminal 230 VAC, 300 VA (W)
KL2761	1-channel universal dimmer terminal 230 V AC, 600 VA (W)
KL2808	HD Bus Terminal, 8-channel digital output 24 V DC
KL2809	HD Bus Terminal, 16-channel digital output 24 V DC
KL2872	16-channel digital output 24 V DC, flat-ribbon cable connection
KM2614	4-channel relay module 230 V AC, 16 A
KM2652	2-channel relay module 230 V AC, 6 A, manual/automatic operation

Analog input

Product	Description
KL3061	1-channel analog input 0…10 V
KL3062	2-channel analog input 0…10 V
KL3064	4-channel analog input 0…10 V
KL3112	2-channel analog input 0…20 mA
KL3202	2-channel input PT100 (RTD)
KL3204	4-channel input PT100 (RTD)
KL3208-0010	HD Bus Terminal, 8-channel input PT1000, Ni1000 (RTD)
KL3403	3-phase power measurement terminal
KL3444	4-channel analog input 0…20 mA
KL3458	8-channel analog input 4…20 mA
KL3468	8-channel analog input 0…10 V
KL3681	Digital multimeter terminal
KM3701	1-channel differential pressure measuring terminal -100…+100 hPa
KM3702	2-channel absolute pressure measuring terminal 7,500 hPa (7.5 bar)
KM3712	2-channel absolute pressure measuring terminal -1,000…+1,000 hPa (-1…+1 bar)

Analog output

Product	Description
KL4001	1-channel analog output 0…10 V
KL4002	2-channel analog output 0…10 V
KL4011	1-channel analog output 0…20 mA
KL4012	2-channel analog output 0…20 mA
KL4404	4-channel analog output 0…10 V
KL4408	8-channel analog output 0…10 V
KL4414	4-channel analog output 0…20 mA
KL4418	8-channel analog output 0…20 mA
KM4602	2-channel analog output 0…10 V, manual/automatic operation

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Communication

Product	Description
KL6021-0023	Serial interface for processing signals from the KL6023 wireless adapter with EnOcean radio technology
KL6023	Wireless adapter for EnOcean radio technology
KL6031	Serial interface RS232
KL6041	Serial interface RS422/RS485
KL6301	EIB/KNX Bus Terminal
KL6401	LON Bus Terminal
KL6581	EnOcean master terminal
KL6583	EnOcean transmitter and receiver for the KL6581
KL6771	MP-Bus master terminal
KL6781	M-Bus master terminal
KL6811	DALI/DSI master and power supply terminal
KL6831	SMI master terminal, LoVo
KL6841	SMI master terminal 230 V AC
EL6851	DMX master terminal
EL6851-0010	DMX slave terminal

Safety

Product	Description
KL1904	4-channel digital input, TwinSAFE, 24 V DC
KL2904	4-channel digital output, TwinSAFE, 24 V DC
KL6904	TwinSAFE Logic Bus Terminal

Manual operating modules

Product	Description
KL8500	Placeholder module
KL8519	16-channel digital input signal module
KL8524	4 x 2-channel digital output module
KL8528	8-channel digital output module
KL8548	8-channel analog output module 0…10 V

System terminals

Product	Description
KL9010	End terminal
KL9160	Potential supply terminal, 120…230 V AC, with diagnostics
KL9184	HD Bus Terminal, 16-channel potential distribution
KL9186	Potential distribution terminal
KL9187	Potential distribution terminal
KL9210	Potential supply terminal, 24 V DC, with diagnostics and fuse
KL9260	Potential supply terminal, 120…230 V AC, with diagnostics and fuse
KL9309	Adapter terminal for manual operating modules
KL9380	Potential distribution, 2 x 230 V AC, 2 x 0 V, 2 x PE, with X2 suppressor capacitor
KL9400	Power supply unit terminal for K-bus refresh

For our complete Bus Terminal portfolio please refer to

▶ **www.beckhoff.com/BusTerminal**

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www.beckhoff.com/building

The online manual

The Beckhoff Information System contains information about the Beckhoff products and technical information, manuals, TwinCAT example codes, a knowledge base and much more.

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PC-based control technology from Beckhoff, which has already been used successfully for almost three decades in all areas of industrial automation, has become an integral component of intelligent building automation. The demands on the intelligence of buildings have increased constantly in recent years, such that the energy efficiency as well as a good "return on investment" is the priority.
The idea of a "green building" based on sustainable, energyefficient construction and building use can be realised with intelligent, integral building automation. Beckhoff offers a universal, scalable building automation control system covering PC- and Ethernetbased controllers and a modular I/O system for logging all data points in buildings.
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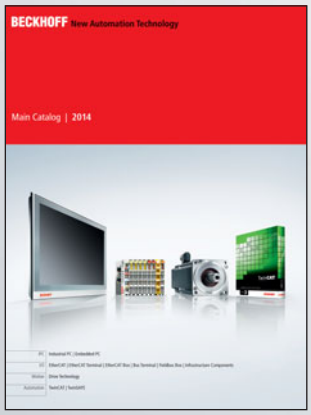

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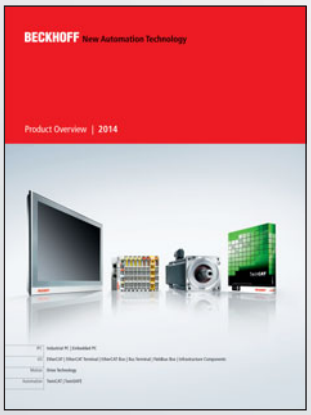

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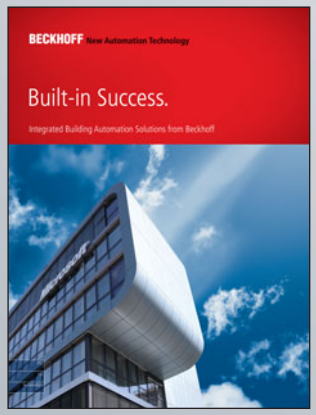

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